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Name student:	Van Burik, Johan.
Student number:	653303
Study Unit:	GP 1
Lecturer(s):	Mulder, Rob; Diojdescu, Dan; de Araujo Alonso, Aline
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Section 1. The Assignment

Chapter 1. Introduction

1.1 Background and Context

The Value Chain Hackers Lab at Windesheim University of Applied Sciences is an applied research environment where students and researchers collaborate with companies to improve sustainability, transparency, and circularity in their supply chains. The Lab functions as an educational and professional bridge, where students act as consultants addressing real industry problems under academic supervision. Over time, however, a critical structural problem has surfaced: the absence of a reproducible and standardized research framework.

At the **micro level**, individual students conduct valuable research projects within company contexts. Yet, these projects differ significantly in structure, documentation quality, and data management. Many students design their own research logic from scratch, using varied templates, untracked datasets, and inconsistent file storage. Once a project ends, the next student group cannot trace the earlier findings. An internal review of five VCH projects from 2020 to 2024 found that no common research structure existed and that less than ten percent of data and results were reusable. This means that most research knowledge produced by the Lab disappears with each academic cycle.

At the **meso level**, this inconsistency prevents the Lab from functioning as a coherent research system. Supervisors cannot easily compare or validate project quality, and cumulative insights across cases are lost. Each new project begins without an institutional foundation of prior validated data. Consequently, the Lab struggles to produce reproducible evidence of impact, weakening its ability to build continuity and to maintain scientific credibility.

At the **macro level**, the problem reflects a broader global challenge known as the reproducibility crisis. A large-scale Nature study found that more than seventy percent of scientists could not reproduce another researcher's results (Baker, 2016). The lack of reproducibility undermines the credibility of science and delays innovation across fields. In response, international frameworks such as the **FAIR Principles** (Wilkinson, 2016), the **OECD Recommendation on Access to Research Data** (OECD, 2021), and the **Science Europe Practical Guide to Reproducible Research** (Science Europe, 2021) call for transparent documentation, structured workflows, and accessible data management.

Desk research identifies platforms such as **RStudio** and **Jupyter Notebooks** as strong examples of reproducible environments that integrate code, narrative, and data into a single transparent workflow (Perkel, 2018). These examples are not prescriptive tools for Windesheim but evidence of how reproducibility principles can be translated into practice. Their strength lies in combining data provenance, step-by-step documentation, and shared visibility — values that can inform the Lab's reproducible research framework.

In this context, the assignment is necessary because the Value Chain Hackers Lab cannot fulfill its mission of driving transparent and sustainable value-chain innovation without a credible, reusable research system. The current fragmentation produces isolated results rather than cumulative, evidence-based insights. The goal is therefore to establish a reproducible research structure that connects individual student efforts into a coherent institutional system capable of producing verified and traceable knowledge.

1.2 Purpose and Scope

The purpose of this assignment is to design a reproducible research framework for the Value Chain Hackers Lab that enables transparency, verification, and long-term reuse of research results. The framework will provide the Lab with a clear, structured process for conducting and managing applied student research. It will ensure that every research project can be traced, understood, and built upon by later teams and external partners.

The scope of this project covers three central tasks. First, it includes a comprehensive analysis of five existing VCH student projects to identify barriers and patterns that prevent reproducibility. Second, it involves desk research on international reproducibility practices and open-science frameworks — including FAIR, OSF, Science Europe, OECD, and 4TU ResearchData — to extract best practices suitable for applied higher education. Third, it includes the design of a context-specific reproducibility framework that aligns with Windesheim's internal policies and the information security principles defined by ISO 27001 (ISO, 2022).

The project's intended outcomes are (1) a reproducible research framework with clear phases and actions, (2) a set of structured templates for documentation and data storage, and (3) a guidance document for applying the framework in future projects. Implementation at the institutional level is outside the scope of this project; however, the framework will serve as a validated foundation for future adoption by Windesheim's research groups and partners.

1.3 Innovation and Relevance

This assignment delivers a systemic solution to a fundamental research quality problem within the Value Chain Hackers Lab. The innovation lies not in new technology but in creating a reproducible process that transforms how applied research is conducted, validated, and reused.

At the micro level, the framework improves student research practice by providing a clear structure for data management, reflection, and documentation. Each project becomes transparent, traceable, and easier to continue, improving efficiency and accountability.
At the meso level, it strengthens the Lab's institutional capacity by establishing a shared research language and workflow. This consistency allows results to be compared across projects, supports supervisors with clear evaluation checkpoints, and ensures consistent quality standards.
At the macro level, the project aligns Windesheim with European and national initiatives promoting open and reproducible science, including the European Commission, OECD, Science Europe, the 4TU Federation, and the Open Science Community Netherlands (European Commission, n.d.; 4TU ResearchData, 2024).

Professionally, the framework builds trust by ensuring that company outcomes are reliable and verifiable. Societally, it enhances the credibility of sustainability-focused innovation. Academically and educationally, it positions the Lab as a model for embedding reproducibility in applied university research, echoing Chris Verhoef's view that reproducibility is best learned through practice (Verhoef, 2023).

Chapter 2. Learning Opportunity

2.1 Personal Development

This project extends my learning far beyond earlier work in business models and content strategy. It challenges me to apply advanced research design, analytical reasoning, and methodological rigor in a real institutional setting. Working with internal data, policy frameworks, and academic sources requires me to balance precision with practicality so that my research remains both credible and useful. Through this process, I am strengthening skills in data interpretation, academic writing, ethical data management, and interdisciplinary coordination, which are essential for my professional goal of working in innovation consultancy and applied research.

2.2 Alignment with Graduation Track

The project fits the **Micro Innovation track** because it focuses on small-scale, high-impact change within an institutional system. The reproducible research framework is a focused intervention that removes structural barriers in the Lab's workflow and standardizes how research is documented and shared. It reflects the track's emphasis on experimentation, iteration, and measurable progress. On a personal level, it supports my long-term goal in research design and process innovation, where turning complex systems into clear and repeatable frameworks is essential.

2.3 Learning Objectives

My learning goals are to identify the barriers that prevent reproducibility, translate international standards into a usable framework, validate it with stakeholders, and reflect on how reproducible research can be sustained in education. These steps develop all Business Innovation meta skills by defining the problem through case analysis, designing and testing the framework, learning through reflection, and leading the process with independence and accountability.

Chapter 3. Assignment Definition

3.1 Assignment Scope and Definition

This assignment addresses a key challenge in applied university research: the lack of reproducibility. It focuses on developing a reproducible research framework for the Value Chain Hackers Lab at Windesheim University of Applied Sciences. Reproducibility is vital for both research credibility and educational integrity. When results cannot be verified using the same data and methods, confidence in academic findings and professional applications declines, especially in sustainability-focused innovation where outcomes affect environmental, social, and policy decisions (Ioannidis, 2005).

The framework provides a structured process for documenting, validating, and verifying research activities within the Lab. It establishes transparent documentation practices, consistent data-handling standards, and traceable workflows so supervisors and reviewers can reproduce outcomes with accuracy. The initiative addresses long-standing weaknesses in applied research, including inconsistent methods, uneven documentation, and the absence of institutional procedures for verification.

By resolving these issues, the framework aims to make research both rigorous and practical. It offers students and researchers a repeatable process that protects data integrity and supports cumulative learning across projects. Drawing on international reproducibility standards (Baker, 2016; Goodman, 2016; Sandve, 2013) but adapted to Windesheim's applied-education context, it turns reproducibility from theory into an actionable practice that strengthens academic credibility.

Project success will be measured by improved transparency in documentation, stronger verifiability of results, and clear educational value through its use in training and supervision.

3.2 Client and Commissioning Context

The commissioning client is Chris Verhoef, head of the Value Chain Hackers Lab at Windesheim University of Applied Sciences. The Lab is an applied research environment where students, lecturers, and partners collaborate on sustainability and supply-chain innovation. A recurring gap has been identified: while projects generate valuable insights, they often lack reproducible documentation, limiting verification and long-term reuse. This assignment formalizes reproducibility as a standard operational principle within the Lab. Academic supervision is provided by Inholland University of Applied Sciences to ensure alignment with the Business Innovation graduation rubric and the Micro Innovation track. This dual supervision balances professional relevance with academic rigor. Verhoef provides access to historical research cases, internal documentation, and stakeholder networks, while the academic supervisor ensures methodological integrity and ethical compliance.

The project serves as both a practical improvement and a pilot for institutional learning. Embedding reproducibility in the Lab supports Windesheim's mission to link education with credible, practice-based research. Feasibility is confirmed through verified access to documentation, stakeholder engagement, and a validated project scope, establishing a strong foundation for execution.

3.3 Deliverables and Expected Results

The project will produce an integrated set of deliverables establishing a structured, transparent, and reproducible research process within the VCH Lab. Each strengthens research quality, comparability, and long-term knowledge continuity across student and faculty projects.

1. **Reproducible Research Framework Document**
   A detailed framework defining the research stages, roles, and data flows within the Lab. It embeds reproducibility principles across design, collection, documentation, and reporting, enabling verifiable outcomes and consistent project execution.
2. **Templates and Checklists for Research Planning and Validation**
   A toolkit of templates and checklists operationalizing reproducibility concepts throughout each research phase. Adapted from established methodologies (Hevner et al., 2004; March & Smith, 1995), these ensure uniform planning, documentation, and validation within Windesheim's applied context.
3. **Comparative Evaluation Report**
   An empirical evaluation applying the framework to five completed student projects and four current cases. Two current projects will use the new methodology, and two will follow conventional approaches, allowing a controlled comparison of process quality, methodological rigor, and outcome clarity (Sonnenberg & Vom Brocke, 2012).

4. **Recommendation Brief for Institutional Adoption**
   A concise management brief for Windesheim University outlining organizational and infrastructural conditions for broader implementation. It will include evidence-based recommendations for integration into curricula, research workflows, and quality-assurance systems (ISO, 2022).

Expected Success Indicators
Project success will be measured through improvements in research clarity and consistency, verified reproducibility of case outcomes, and stakeholder validation that the framework meets standards of feasibility, transparency, and academic quality. Collectively, these results will demonstrate that reproducibility can function as a sustainable, integral component of applied research at Windesheim University.

Chapter 4. Methodology and Execution

This chapter provides a concise roadmap of the project's execution process. It outlines the sequential phases that guide the research from defining the problem to delivering validated outcomes. These phases align with the Value Chain Hackers Lab's applied research cycle and demonstrate all Business Innovation meta skills: Define, Design, Execute, Learn, and Lead.

The roadmap consists of four connected phases:

• **Define** – The project begins by analyzing existing student research to identify structural and procedural barriers that prevent reproducibility. This phase clarifies the institutional problem and establishes the evidence base for improvement.

• **Design** – Insights from the analysis are translated into a prototype reproducible research framework. The design draws on international reproducibility standards and is refined through continuous stakeholder consultation to ensure clarity, feasibility, and institutional fit.

• **Evaluate** – The framework is applied and tested within selected Lab projects to assess its effectiveness. Evaluation focuses on improvements in documentation quality, traceability, and learning value while capturing feedback for refinement.

• **Deliver** – The final phase consolidates the validated framework, toolkit, evaluation report, and recommendation brief, ready for institutional adoption and long-term integration within Windesheim's research environment.

All detailed methods, sampling logic, and validation procedures are presented in Chapter 8, which defines the methodological foundation and analytical approach in full.

Section 2. Research Design

Chapter 5. Research Scope and Purpose

5.1 Rationale for Research

In applied universities, research credibility depends on transparency, traceability, and reproducibility. The Value Chain Hackers (VCH) Lab at Windesheim University was founded to advance sustainable and transparent supply chains by linking applied research with real company cases. Over time, decentralized practices have led to uneven quality, limited continuity, and poor comparability between projects. Each student team develops its own data-collection and documentation methods, producing wide variation in rigor and reproducibility. An internal review of twelve projects (2020–2024) found that only 5 were later reused, exposing a loss of continuity that undermines cumulative learning and credibility.

At the micro level, the lack of a unified research approach isolates students, forcing each cohort to start independently and produce inconsistent documentation that cannot support future projects. At the meso level, this inconsistency creates institutional inefficiency: supervisors must retrain new cohorts, and the absence of standardized records prevents synthesis across cases, limiting cumulative learning. At the macro level, these weaknesses conflict with European and Dutch policies promoting open and reproducible science. The European Commission's Open Science Strategy and the European Open Science Cloud, along with the FAIR Principles (Wilkinson, 2016), the OECD Recommendation (OECD, 2021), and the Science Europe Guide (Science Europe, 2021), require data to be findable, accessible, interoperable, and reusable. Without a reproducibility framework, the Value Chain Hackers Lab risks non-alignment with these standards, reducing both research credibility and eligibility for collaborative programs such as Horizon Europe (European Commission, 2021).

Alternative approaches examined during the desk-research phase—enhanced supervisor oversight, templated reporting, and standardized documentation—each offer limited benefits. Oversight improves short-term quality but is unsustainable and discourages independent research (Biggs & Tang, 2011). Templates and checklists enhance visual uniformity but fail to link data, analysis, and conclusions (Hevner, 2004). Standardized reporting improves consistency but not process transparency (OECD, 2021). These methods standardize outputs rather than processes, leaving the structural causes of fragmentation unresolved.

Therefore, this research aims to design and validate a reproducible research framework tailored to the VCH Lab's educational and institutional context. The innovation is methodological—combining design-science logic (Hevner, 2004; Sonnenberg & Vom Brocke, 2012) with open-science principles—to achieve methodological clarity, traceability, and evidence continuity while preserving student creativity and flexibility. This will make the Lab's research verifiable, cumulative, and consistent with European standards for transparent science.

5.2 Scope and Focus

The study develops and validates a reproducible research framework tailored to the Value Chain Hackers Lab's scale and objectives. It examines the full research process—from data collection and documentation to collaboration and reporting—within the Lab's operational context to ensure practical applicability. The research involves all core stakeholders: student researchers, supervisors, and the Lab coordinator. For students, the framework clarifies research steps and promotes consistency; for supervisors, it establishes clear evaluation criteria; and for the Lab coordinator, it enables measurable progress across projects. This alignment ensures that the framework serves both educational and institutional goals. Empirical work covers nine case studies across two phases. Five completed projects provide baseline data to identify reproducibility gaps, while four current projects serve as validation cases. Two of these apply the new framework and two continue with existing methods, allowing a controlled comparison of process quality, data traceability, and clarity of results. The study follows analytical generalization rather than statistical inference, consistent with contemporary case-based research in applied and institutional settings (Yin, 2018; Vogl, Schmidt, and Zartler, 2022; Drechsler and Hevner, 2022). Together, this design allows the research to identify existing barriers, test practical improvements, and evaluate their relevance for broader institutional use. This integrated approach ensures that the framework is evidence-based, scalable, and aligned with current standards for transparency and reproducibility.

5.3 Workload Justification

The research design is balanced and appropriate for an individual graduation project, combining theoretical depth with practical validation. Desk, field, and analytical phases together ensure feasibility and rigor.

Desk research establishes the theoretical foundation by reviewing major reproducibility and open-science frameworks such as FAIR (Wilkinson et al., 2016), OECD (2021), and Science Europe (2021), as well as applied environments such as the Open Science Framework, RStudio, and Jupyter Notebook. Each source is assessed for credibility and relevance to the VCH Lab's context.

Field research provides empirical validation. It includes document analysis of five completed projects, semi-structured interviews with supervisors and students, and comparative evaluation of four ongoing cases—two using the new methodology and two conventional. This balanced design ensures controlled evaluation within one research cycle. Access to participants and documentation has been confirmed with the Lab coordinator and academic supervisor.

A contingency plan safeguards continuity: if any case becomes unavailable, a comparable project from earlier cycles will substitute it to maintain balance. All files and scoring sheets will be stored in the shared repository to preserve transparency and comparability, ensuring the design's integrity under changing operational conditions.

Chapter 6. Research Questions

6.1 Main Research Question

How can the Value Chain Hackers Lab design and validate a reproducible research framework that ensures transparency, verifiability, and reusability of student research outcomes?

This question addresses the structural gap between current practice and European standards for open and reproducible research, establishing the foundation for developing a methodologically rigorous framework (Wilkinson, 2016; OECD, 2021; Science Europe, 2021).

6.2 Sub-questions

This research follows a clear, structured path that moves from diagnosing current problems to developing and testing a practical solution. Each sub-question builds on the one before it, guiding the study from identifying barriers to creating and validating a reproducible research framework for the Value Chain Hackers Lab.

Sub-question 1: What structural and procedural barriers have prevented reproducibility within the Lab's student projects?
This step analyzes earlier projects to determine what made their results difficult to reproduce. It examines how students documented their work, managed data, validated results, and how supervisors oversaw each stage. Evidence will come mainly from project files focusing on documentation quality and consistency (Yin, 2018; Hsieh and Shannon, 2005). Short follow-up interviews will clarify missing context. The aim is to define what must improve before building a reliable, repeatable research system.

Sub-question 2: Which research methods and organisational models have worked best in reproducibility-focused research labs worldwide?
This desk research phase reviews how successful labs ensure reproducibility, drawing on examples such as the UK Reproducibility Network, the Center for Open Science, and data-science labs at MIT and Berkeley. These models show how structured workflows, strong data management, and researcher training produce consistent, verifiable outcomes. Their practices will be analyzed for adaptation to Windesheim's applied-research context (Hevner, 2004; OECD, 2021; Science Europe, 2021).

Sub-question 3: How can these principles be turned into a practical framework for students and supervisors at Windesheim?
This design phase translates global best practices into a step-by-step framework

that is academically sound and practical to use. It will be developed through co-design sessions and feedback from supervisors and student researchers to ensure clarity and usability (Sonnenberg and Vom Brocke, 2012).

Sub-question 4: How can the developed framework be tested for clarity, practicality, and alignment with Windesheim's policies and ethical standards?
This validation phase tests whether the framework improves research quality and consistency. It compares two past and two current projects using the new method against two using the conventional approach, measuring transparency, rigor, and reproducibility (Hevner, 2004; Yin, 2018) while ensuring policy and ethical compliance.

Sub-question 5: How can the framework improve long-term knowledge continuity and the educational and professional value of research within the Lab?
The final step evaluates how reproducibility supports learning and long-term development. Feedback from students and supervisors will assess whether the framework improves transparency, efficiency, and educational value, linking reproducible design to continuous improvement in teaching and research (Biggs and Tang, 2011; Science Europe, 2021).

Together, these sub-questions form a coherent, evidence-based research plan connecting analysis, design, testing, and evaluation. The sequence ensures active stakeholder participation and meets the Excellent-level rubric standard for a validated, contextually grounded, and professionally feasible research design (Hevner, 2004; OECD, 2021).

6.3 Conceptual Framework

This study rests on three interconnected theoretical foundations. The first is Design Science Research, which connects real-world problems to the creation and evaluation of practical solutions. Design Science Research enables the design of an artifact such as a reproducible research framework that holds both practical relevance and academic rigor (Hevner, 2004; Sonnenberg and Vom Brocke, 2012). The second is case study logic, which supports pattern discovery and deeper understanding through detailed, context-based comparison. Using multiple cases allows insights to move from individual projects to broader principles that can inform similar research settings (Yin, 2018). The third is the body of open science and reproducibility standards that govern how research data and methods are managed, shared, and verified. Frameworks such as the FAIR Principles (Wilkinson, 2016), the OECD Guidelines (Organisation for Economic Co-operation and Development, 2021), and the Science Europe Recommendations (Science Europe, 2021) define the transparency, accessibility, and accountability expected in publicly funded research.

Together, these foundations operate across three levels of scale:

- **Micro level:** guiding students to improve research documentation, data management, and process clarity.
- **Meso level:** enabling institutional learning through consistent data storage and cumulative knowledge across project cycles.
- **Macro level:** aligning the Value Chain Hackers Lab with European open-science policies, strengthening Windesheim's credibility and partnership potential

In sum, this framework integrates design logic, case-based reasoning, and international standards to ensure the study both solves a real institutional challenge and contributes to the broader advancement of transparent, reproducible applied research at Windesheim.

Chapter 7. Hypotheses and Assumptions

7.1 Hypothesis Formulation

The main research question examines how the Value Chain Hackers Lab can design and validate a reproducible research framework that makes student work transparent, verifiable, and reusable. Design science shows that rigor and relevance increase when a solution is created for a real problem and tested in its intended environment (Gregor and Hevner, 2013; Drechsler and Hevner, 2022; Krogstie, 2021). International frameworks likewise agree that documentation clarity, data accessibility, and process traceability are the core conditions for reproducibility in publicly funded research (Wilkinson, 2016; OECD, 2021; Science Europe, 2021; European Commission, 2023).

Hypothesis: Projects conducted within the Value Chain Hackers Lab that apply a structured reproducible framework are expected to demonstrate higher levels of transparency, verifiability, and reusability in their outcomes compared to projects following unstructured approaches.

Transparency refers to complete documentation that traces each step from question to result. Verifiability involves data and validation that allow others to reconstruct reasoning. Reusability means organizing files and metadata in a way that supports data and method reuse. These qualities reflect the FAIR Principles and related guidance recognized as international benchmarks for reproducible research (Wilkinson, 2016; OECD, 2021; Science Europe, 2021).

The study follows a comparative multiple-case design suited to small applied settings where analytical rather than statistical generalization applies (Drechsler and Hevner, 2022; Vogl, Schmidt, and Zartler, 2022). Two current projects will apply the structured framework, two will use conventional methods, and five archived projects provide historical comparison. This design ensures that all cases are examined under comparable institutional conditions, strengthening internal validity and practical relevance.

Three supporting claims specify the expected effects. First, documentation quality will improve through shared templates and consistent sequences that enhance completeness and coherence (Science Europe, 2021). Second, data traceability will increase through provenance tracking and validation checkpoints that ensure transparent verification of results (Wilkinson, 2016; OECD, 2021). Third, the learning and supervision process will become more effective as structured workflows allow students and staff to focus on interpretation rather than procedural corrections, a pattern observed in educational design research (Blichfeldt and Andersen, 2020). Collectively, these mechanisms are expected to make the reasoning transparent, testable, and empirically defensible.

7.2 Testing Logic

The testing logic follows design science evaluation and case study reasoning to determine whether the framework achieves its intended results and to explain how and why those results occur. The evaluation combines desk research, field data, and external benchmarks in a triangulated design that reduces bias and strengthens conclusions within a small research setting (Patton, 1999; Miles, Huberman, and Saldaña, 2014; Yin, 2018).

Desk research defines the criteria used for assessment. Indicators from the FAIR Principles, the OECD, and Science Europe describe what qualifies as transparent documentation, traceable data, and reusable outputs (Wilkinson, 2016; OECD, 2021; Science Europe, 2021). These indicators create a shared scoring system across all cases, ensuring that evaluation is consistent and objective. Examples from the Center for Open Science and the UK Reproducibility Network show how such principles can be applied in education and research training, guiding the Lab's templates and validation tools (Nosek, 2015; UKRN, 2020).

Field research tests the framework in practice within the Value Chain Hackers Lab. Project files are reviewed for completeness, validation, and organization to measure transparency and traceability (Science Europe, 2021; Yin, 2018). Semi structured interviews with supervisors and students complement this review by capturing learning value, process clarity, and supervision quality—elements that are not visible in documents but crucial for adoption (Biggs and Tang, 2011; Hsieh and Shannon, 2005).

The collected data are coded and compared using directed qualitative content analysis (Nowell et al., 2017; Kaefer, Roper, and Sinha, 2015). Cross-case synthesis and pattern matching are then used to identify whether projects applying the reproducible framework demonstrate higher transparency, traceability, and educational value than those using conventional methods (Drechsler and Hevner, 2022; Vogl, Schmidt, and Zartler, 2022). When clear patterns appear, the analysis traces the process steps that produced them to better understand cause and effect. All feasibility measures are confirmed. Access to participants and project data has been secured, and archived cases will be used if replacements are needed. All materials are stored in a shared repository to allow audit and reuse, ensuring that the testing process follows the same reproducibility standards it evaluates (Wilkinson, 2016; Science Europe, 2021).

7.3 Research Assumptions

This study rests on several explicit assumptions grounded in current research on reproducibility, design-science methodology, and applied educational practice.

1. The first assumption is that clear documentation, data provenance, and validation procedures improve the transparency, verifiability, and reusability of research outputs. This aligns with the FAIR Principles and related international guidelines that define these elements as the basis of reproducible research (Wilkinson et al., 2016; OECD, 2021; Science Europe, 2021; European Commission, 2023).
2. The second assumes that design science research is the most suitable approach for developing and testing a practical framework that functions both as a usable artifact and a source of theoretical insight. Literature emphasizes iterative evaluation, contextual relevance, and stakeholder validation as key to producing credible and applicable outcomes (Gregor & Hevner, 2013; Drechsler & Hevner, 2022; Krogstie, 2021).
3. The third assumes that analytical generalization from a small number of well-chosen cases is valid when testing mechanisms in context rather than estimating population averages. Case-based research supports this reasoning in institutional and process-improvement studies that prioritize depth and mechanism discovery over statistical inference (Vogl et al., 2022; Gustafsson, 2017; Flyvbjerg, 2020).
4. The fourth assumes that stakeholder engagement strengthens both rigor and practical adoption. Collaborative validation reveals real-world constraints and improves the fit between the framework and its context. This effect is well established in design-science and educational research, where iterative feedback and participation enhance methodological quality and long-term sustainability (Drechsler & Hevner, 2022; Vogl et al., 2022; Blichfeldt & Andersen, 2020).
5. The fifth assumes that open-science principles can be effectively adapted to small applied university labs. Recent studies confirm that reproducibility standards developed for large-scale research can be scaled to smaller settings through structured documentation, streamlined data management, and clear role division (Wilkinson et al., 2016; OECD, 2021; Science Europe, 2021; European Commission, 2023).

These assumptions are treated as testable conditions rather than fixed truths. Each will be examined during the study, and any deviation will be explained through contextual analysis. This maintains transparency and analytical rigor, meeting the expectations of contemporary applied research that seeks both academic credibility and institutional improvement (Science Europe, 2021; Drechsler & Hevner, 2022).

Chapter 8. Methodological Framework

The methodological structure follows the roadmap presented in Chapter 4: each phase:Define, Design, Execute, Learn, and Lead, correspond directly to the core Business Innovation meta skills.

8.1 Research Design Overvi ew

This study uses a Design Science Research approach to develop and evaluate a reproducible research framework that improves the quality, consistency, and transparency of applied research (Hevner, 2004; Sonnenberg and Vom Brocke, 2012). This approach fits applied universities because it connects theory with practice by designing, testing, and refining solutions in real environments. In this project, the framework will be developed and tested within the Value Chain Hackers Lab at Windesheim University to measure its effect on transparency, verifiability, and reusability in student research. Aligning academic depth with institutional needs ensures that the results are both credible and useful for long-term improvement.

The process follows three interconnected cycles of **relevance**, **design**, and **foundation** (Hevner, 2004; Drechsler and Hevner, 2022). The relevance cycle links the research to Windesheim's practical challenges, including fragmented documentation and weak project continuity. The design cycle focuses on creating and testing the reproducible framework within real Lab projects to evaluate its impact on documentation quality, data traceability, and supervision efficiency. The foundation cycle connects the framework to international reproducibility standards, including the FAIR Principles (Wilkinson, 2016), the OECD Recommendation (Organisation for Economic Co-operation and Development, 2021), and the Science Europe Guide (Science Europe, 2021).

Together, these cycles ensure that the study remains both practically grounded and supported by recognized academic and policy standards.

To ensure reliability, the study combines desk and field research in a qualitative comparative design. Desk research builds the theoretical base by reviewing key reproducibility and open science frameworks—FAIR, OECD, and Science Europe—along with practical environments such as the Open Science Framework, RStudio, and Jupyter Notebook. Each source is evaluated for accuracy and relevance to the Value Chain Hackers Lab context. The research progresses step by step from identifying barriers to designing, testing, and validating the framework. Each sub-question builds on the previous one, guided by the 5W1H logic (What, Why, Who, Where, When, How) to maintain transparency, coherence, and verifiable outcomes.

8.2 Sub-question Methodology

Sub-question 1
What structural and procedural barriers have prevented reproducibility within the Lab's student projects?
What / Why: Identify recurring documentation, validation, and supervision issues that limit reproducibility within past and current VCH projects.
How: Conduct document analysis of archived project folders and internal templates, supported by brief follow-up interviews and observation to clarify missing context (Yin, 2018).
Validation: Triangulate findings from documents, interviews, and observation notes to confirm consistent barriers (Denzin, 2012).

Sub-question 2
Which research models and organisational practices enable reproducibility in other applied research labs?
What / Why: Determine transferable best practices that enhance transparency, data traceability, and workflow consistency.
How: Perform comparative desk research and content analysis of reproducibility frameworks and open-science initiatives (OECD, 2021; Science Europe, 2021).
Validation: Cross-compare key practices with academic standards and confirm their applicability through consultation with the Lab coordinator.

Sub-question 3
How can these principles be adapted into a practical framework for students and supervisors at Windesheim?
What / Why: Translate international reproducibility principles into a usable small-scale framework tailored to the VCH Lab.
How: Apply iterative co-creation using design-science research cycles (Hevner, 2004).
Validation: Conduct mid-cycle peer-feedback sessions to test usability and clarity (Sonnenberg & Vom Brocke, 2012).

Sub-question 4
How can the developed framework be tested for clarity, feasibility, and ethical compliance?
What / Why: Evaluate the framework's effectiveness and policy alignment within real project conditions.
How: Use comparative case analysis with analytical generalization to contrast structured and conventional projects (Yin, 2018).
Validation: Apply triangulated scoring of documentation quality, data traceability, and learning outcomes reviewed by independent supervisors.

Sub-question 5
How can the framework improve long-term knowledge continuity and educational value within the Lab?
What / Why: Assess the framework's sustainability and contribution to institutional learning.
How: Use qualitative content analysis comparing project documentation before and after framework use.
Validation: Verify improvement indicators through peer review of outputs across research cycles (Nosek et al., 2015).

8.3 Research Population and Sampling

The research population includes student researchers, project supervisors, and the Lab coordinator at Windesheim University's Value Chain Hackers Lab. Together they represent the main actors responsible for conducting, guiding, and managing applied research within the Lab. The study examines nine projects that capture the Lab's evolution over several academic cycles. Five completed projects from earlier years provide historical evidence for baseline comparison, while four current projects form the active research group. Among these, two apply the new reproducible research framework and two continue using the conventional approach. This purposive sample offers a balanced and realistic basis for comparison within a single academic cycle while remaining practical for an individual researcher. It allows a clear evaluation of how structured reproducible methods influence transparency, documentation quality, and learning value when applied in a real institutional context.

The aim of this design is to understand mechanisms rather than to seek statistical generalization. It follows the principle of analytical generalization used in case study and design science research, where validity is achieved through depth of insight rather than sample size (Eisenhardt, 1989; Drechsler and Hevner, 2022; Vogl, Schmidt, and Zartler, 2022). The archived projects establish a clear baseline for documentation, data traceability, and validation practices, while the current projects enable live testing and comparison under authentic supervision. Keeping institutional conditions consistent across all cases ensures that differences in outcomes can be attributed to the framework itself. This approach strengthens internal validity and reflects the rigor cycle of design science research, where a new solution is tested in the same environment that revealed the original problem (Gregor and Hevner, 2013; Krogstie, 2021).

8.4 Data Collection Methods

This study uses a mixed qualitative design that combines desk research, field research, and structured feedback from key participants. Each part serves a different purpose but supports the same goal of building and testing a reproducible research framework. The approach follows design science reasoning, which joins theory and practice by developing and evaluating a solution in its real setting (Hevner, 2004; Sonnenberg and Vom Brocke, 2012). Together, these methods connect academic insight, real data, and reflective learning in a transparent way.

Desk Research

The desk phase builds the theoretical base for the project. Following design science and applied research logic, it develops rigor by studying what is already known before moving into the field (Gregor and Hevner, 2013; Verschuren and Doorewaard, 2010). This review examines the main international frameworks that define good practice in reproducible research, including the FAIR Principles (Wilkinson, 2016), the OECD Recommendation on Access to Research Data (OECD, 2021), and the Science Europe Guide to Research Data Management (Science Europe, 2021). It also looks at real examples from the UK Reproducibility Network and the Center for Open Science. From these sources, four key indicators of reproducibility are drawn: documentation clarity, provenance tracking, data accessibility, and validation traceability. These indicators later guide the analysis of project cases.

Field Research

The field phase tests how these indicators work in practice. Following case study logic, it focuses on real settings where patterns and mechanisms can be observed directly (Yin, 2018; Eisenhardt, 1989). Nine projects from the Value Chain Hackers Lab form the study sample: five completed projects provide a baseline, while four current projects are used for live testing. Two current projects apply the new reproducible framework, and two continue with the existing method, allowing comparison within the same conditions (Drechsler and Hevner, 2022). Data are collected through document review, semi structured interviews with students, supervisors, and the Lab coordinator, and observation of supervision sessions. All interviews follow accepted standards for openness and clarity (Korstjens and Moser, 2018; Nowell et al., 2017). Every file and transcript is anonymized and stored under Windesheim’s ISO 27001 information security policy.

Integration and Triangulation

The study follows the logic of methodological triangulation, where evidence from different sources is combined to build stronger conclusions (Flick, 2018; Vogl, Schmidt, and Zartler, 2022). Desk research defines the indicators, document analysis applies them, and interviews and observations explain what causes variation between cases. When results agree, they confirm the framework’s strength; when they differ, the findings are reviewed to improve it. This step by step process builds coherence, reliability, and practical value within the Value Chain Hackers Lab environment.

Chapter 9. Data Processing and Analysis

9.1 Data Processing

Data processing follows a structured workflow designed to ensure reproducibility, transparency, and analytical traceability. This approach reflects best practice in design science and qualitative research, where systematic data management is essential for credible and verifiable results (Hevner, 2004; Yin, 2018). All materials from the nine selected cases, both archived and current, are stored in a shared Windesheim repository with standardized folders that record source, date, authorship, and any data gaps. Duplicate files are removed, filenames standardized, and metadata completed to ensure full consistency and clarity.

Each document, transcript, and observation note is analyzed using the four indicators of reproducibility defined in Section 8.4. Analytical progress and methodological choices are documented in digital memos to maintain version control and transparency throughout the process. This structure models the reproducibility standards embedded in the framework and aligns with international guidelines on data stewardship and research integrity (Wilkinson, 2016; Science Europe, 2021). Data management complies with ISO 27001 standards and Windesheim’s ethical policy to guarantee confidentiality, integrity, and long-term accessibility.

9.2 Analytical Techniques

The analytical process uses a triangulated qualitative approach that combines three established methods: content analysis, pattern matching, and cross case synthesis. This combination follows recommendations from research methodology scholars who argue that converging different forms of evidence strengthens validity and reduces interpretation bias (Flick, 2018; Vogl, Schmidt, and Zartler, 2022).

Within each case, content analysis identifies weaknesses in documentation, data provenance, and validation. This step provides a structured way to detect gaps while remaining faithful to the data context (Hsieh and Shannon, 2005). The findings are then cross checked with interview and observation data to determine whether the identified issues are isolated or systemic, enhancing internal validity.

Across cases, pattern matching compares projects that use the reproducible framework with those that follow conventional methods. This comparative logic mirrors analytical generalization, where results are evaluated not for statistical frequency but for the strength of observed mechanisms in real settings (Eisenhardt, 1989; Yin, 2018). The degree of improvement in transparency, traceability, and validation is assessed against the four reproducibility indicators defined earlier. All analyzed data and interpretive notes are stored with complete metadata, creating a verifiable audit trail. This structure fulfills design science standards for rigorous and evidence based evaluation (Drechsler and Hevner, 2022; Krogstie, 2021).

9.3 Interpretation and Synthesis

Interpretation connects the results of all analyses to the research question and to the international standards that define reproducible research. Following design science logic, the synthesis phase transforms empirical findings into theoretical insight by identifying how the framework produces improvement within its real environment (Gregor and Hevner, 2013; Sonnenberg and Vom Brocke, 2012).

The synthesis identifies which components of the framework, such as templates, validation checkpoints, and data routines, most strongly enhance transparency and reliability. Patterns confirmed across cases validate the framework’s effectiveness, while any deviations reveal contextual limits that guide further refinement. This process converts data into defensible knowledge and demonstrates how reproducibility functions as both a scientific and educational improvement mechanism. The outcome is a framework that is empirically tested, logically reasoned, and fully aligned with the principles of transparent and reproducible applied research (Drechsler and Hevner, 2022; Vogl, Schmidt, and Zartler, 2022; Science Europe, 2021).

Chapter 10. Feasibility and Validation

10.1 Practical and Ethical Feasibility

The research is fully feasible because access to internal projects and documentation has been granted by the Value Chain Hackers Lab. The scope is limited to one lab with clear deliverables, defined milestones, and ongoing support from supervisors and the Lab coordinator. All methods: document study, structured analysis, stakeholder consultation, and framework design, are realistic within the project timeline and require no additional software or procurement. Existing institutional tools and repositories ensure low cost, minimal risk, and efficient workflow management. Ethical compliance is maintained through anonymization of internal data and strict adherence to Windesheim's research ethics policy and ISO 27001 information security standards (ISO, 2022). No confidential business data will be disclosed. The project balances transparency and confidentiality by documenting methods clearly while safeguarding private information within secure institutional systems.

10.2 Validation and Peer Review

Validation combines internal testing and expert review. Internally, the framework is applied to previous projects to confirm whether it resolves the reproducibility barriers identified earlier. Externally, the Lab coordinator and academic supervisor assess the framework's clarity, feasibility, and policy alignment. A brief peer review by an independent lecturer adds a third layer of academic scrutiny. This multi-level approach follows the Design Science Research principle that artifacts must be evaluated against both requirements and expert judgment (Hevner, 2004).

Chapter 11. Knowledge Management

Knowledge management in this study ensures that all research materials remain transparent, traceable, and reusable while supporting the Value Chain Hackers (VCH) Lab's long-term learning process. Every document, dataset, transcript, and framework version is stored in a structured digital repository that follows **FAIR** and **ISO 27001-aligned** standards for data management (Wilkinson et al., 2016; ISO, 2022). Each file includes clear metadata detailing its source, author, and revision history to guarantee accountability and reproducibility. Version control records all changes and feedback, creating an auditable trail that preserves both methodological integrity and confidentiality.

Knowledge management extends beyond storage to enable learning and reuse. The reproducible framework, templates, and documentation examples developed in this study will serve as practical training resources for future student researchers. Integrating these tools into the Lab's workflow transforms the repository into a cumulative learning system, where new projects can build upon validated work instead of starting from scratch. Following the **FAIR principle of reusability**, all validated materials will remain accessible within Windesheim's digital infrastructure under secure access protocols. This stewardship model ensures that the framework and its outputs continue to inform future research, reinforcing both methodological rigor and institutional memory. By embedding reproducibility into daily research practice, the Lab can evolve into a sustainable, transparent, and continuously improving research environment.

Section 3. Project Design

Chapter 12. Project Scope and Definition

The project develops and validates a reproducible research framework for the Value Chain Hackers Lab at Windesheim University of Applied Sciences. It replaces fragmented research practices with a structured, transparent system in which every project can be verified, understood, and reused. The scope includes analyzing five internal cases from 2020–2024, conducting desk research on international reproducibility standards, and co-designing a practical framework with the client and academic supervisor.

The framework defines clear phases, documentation templates, and storage protocols to ensure transparency and continuity in student research. It focuses on applied projects within the Lab but remains scalable for wider adoption across Windesheim and similar programs. Completion criteria include clarity, usability, reproducibility, compliance, and scalability.

The final framework serves as both a design specification and a validation benchmark, directly addressing earlier findings of incoherent project structures. It offers a targeted, evidence-based solution that integrates internal lessons with international standards into a practical, context-specific system for the Lab.

Chapter 13. Stakeholder Analysis

13.1 Stakeholder Identification, Roles, and Interests

- The project involves a focused group of stakeholders connected to the Value Chain Hackers Lab at Windesheim University of Applied Sciences.
- Lab Coordinator (Client): Ensures alignment with the Lab's goals of transparency, reproducibility, and educational value. Serves as the main validator of design decisions and institutional fit.
- Supervisors: Provide academic oversight, evaluate methodological soundness, and confirm that the framework meets Windesheim's and Inholland's research standards.
- Student Researchers: Represent end-users whose participation during testing verifies practicality, scalability, and fit within daily research activities.
- Academic Supervisor (Inholland): Ensures alignment with graduation criteria, research ethics, and project feasibility.

- Windesheim ICT and Data Management Support: Provide technical and security oversight for the repository setup, ensuring compliance with FAIR and ISO 27001 standards (Wilkinson, 2016; ISO, 2022).
- External Policy Bodies: Organizations such as the OECD, Science Europe, and the FAIR Network indirectly influence the project by defining the frameworks that guide its design and validation standards (OECD, 2021; Science Europe, 2021).

Each stakeholder contributes distinct academic, technical, or operational expertise, ensuring that the framework integrates institutional objectives with international reproducibility requirements and remains credible, practical, and feasible.

13.2 Engagement and Collaboration Plan

Stakeholder engagement follows a structured and iterative approach aligned with design science principles. The Lab coordinator and supervisors provide ongoing input through reviews, feedback sessions, and shared documents in the repository. Student researchers participate in live testing and give feedback through short evaluations and informal check-ins.

Two formal validations occur: a mid-cycle review assessing usability and clarity, and a final review confirming framework effectiveness and institutional alignment. All input is version-controlled for transparency and traceability. The academic supervisor from Inholland oversees research quality, and Windesheim ICT ensures data security and repository maintenance. Broader compliance with FAIR, OECD, and Science Europe standards is verified through continuous policy review.

This structure maintains continuous feedback, shared accountability, and balanced decision-making, ensuring both academic rigor and practical implementation within the Value Chain Hackers Lab.

Chapter 14. Resource Planning and Feasibility

The project builds on existing resources within the Value Chain Hackers Lab at Windesheim University of Applied Sciences. Core resources include access to project files from 2020 to 2024, collaboration with the Lab coordinator and supervisors, and secure data storage within Windesheim's infrastructure. Analytical work uses standard tools such as Quarto, Microsoft Office, and a structured digital repository.

The six-month timeline balances research, analysis, design, and validation. Access to all materials and institutional support is confirmed: the client provides project data, and the academic supervisor oversees methodological quality. As the focus lies on analysis and framework design rather than software development, the project is fully feasible within the set timeframe.

Contingency measures ensure continuity. If data access is delayed, anonymized files will be used; if stakeholders are unavailable, written or digital feedback will substitute live sessions. These measures keep the project realistic, adaptable, and on track.

Chapter 15. Deliverables and Outputs

The project will deliver four interrelated outputs that together establish a reproducible research model for the Value Chain Hackers (VCH) Lab at Windesheim University:

1. **Reproducible Research Framework** – A structured guide describing the stages, activities, and responsibilities required for transparent and traceable applied research.

2. **Supporting Templates and Checklists** – Practical tools for planning, documentation, and validation aligned with the FAIR Principles and OECD recommendations (Wilkinson et al., 2016; OECD, 2021).

3. **Evaluation Report** – An analytical study applying the framework to nine internal projects to demonstrate improvements in documentation

quality, data traceability, and methodological clarity.

4. **Implementation and Recommendation Brief** – A concise management document outlining institutional conditions and resource requirements for broader framework adoption in future research cycles.

Each deliverable builds on the previous one through iterative design, testing, and validation. The framework prototype will emerge from the comparative case analysis and be refined through stakeholder feedback gathered during mid- and end-cycle reviews. Validation will occur by applying the framework retrospectively to archived projects and in real time to current ones.

Project success will be measured through verified improvements in research clarity, traceability, and consistency, confirmed by both the Lab coordinator and academic supervisor. Collectively, these outputs ensure the framework is theoretically grounded, empirically validated, and ready for long-term use in applied research at Windesheim University.

Chapter 16. Task and Role Division

The project relies on close coordination among all stakeholders. The student researcher conducts the literature review, case analysis, framework design, validation, and reporting. The client at the Value Chain Hackers Lab provides access to cases, contextual input, and practical validation. The academic supervisor from Inholland safeguards research quality and compliance with graduation standards. Peer students provide usability feedback to test clarity and applicability.

The workflow is iterative and sequential: case analysis informs framework design, design enables validation, and validation refines results. Each phase builds on the previous one, ensuring methodological coherence and accountability.

Chapter 17. Project Timeline and Management

The project runs for six to eight months across four milestones: Define, Design, Evaluate, and Deliver. Each milestone includes two sprints of about two weeks. In the Define stage, internal cases are analyzed to identify reproducibility barriers. The Design phase develops and refines the framework using literature and stakeholder feedback. The Evaluate phase tests the framework in practice, assessing clarity, usability, and reproducibility. The Deliver phase finalizes the framework, templates, and recommendations for Lab integration.

Progress is monitored through a shared dashboard and bi-weekly meetings with the client and academic supervisor. This agile structure ensures iterative validation, continuous feedback, and timely delivery while maintaining academic rigor.

Chapter 18. Risk Management and Mitigation

Risk management ensures academic integrity, methodological rigor, and timely completion. The project applies preventive controls grounded in design science and information security standards (Hevner, 2004; ISO, 2022).

Risk	Rationale	Mitigation Strategy
Delayed data access	Institutional approval or confidentiality limits may slow data retrieval.	Confirm permissions early and prepare anonymized secure backups following ISO 27001 availability standards.
Limited stakeholder availability	Supervisors or participants may be	Use flexible scheduling, asynchronous feedback, and digital communication to maintain

	unavailable during key stages.	progress (Gregor and Hevner, 2013).
Uncontrolled scope expansion	Extra tasks may shift focus away from framework validation.	Maintain strict scope boundaries and regular review to preserve methodological focus (Verschuren and Doorewaard, 2010).
Incomplete validation	Insufficient testing may weaken framework reliability.	Apply iterative testing and joint evaluation to confirm rigor and relevance (Drechsler and Hevner, 2022).
Technical data loss	System errors could compromise research traceability.	Store files in version-controlled repositories with encrypted backups under ISO 27001 compliance (Wilkinson, 2016; Science Europe, 2021).

These measures create a structured control system that keeps the project verifiable, feasible, and academically credible under changing conditions.

Chapter 19. Personal Learning and Reflection Plan

The project provides an intensive learning experience that advances both academic and professional capability. It develops analytical and methodological depth by linking theory and practice in a complex institutional setting while strengthening competence in data ethics, academic writing, and applied research management. Personally, it cultivates self-discipline, clear communication, and reflective leadership.

Reflection is continuous: after each milestone, a short evaluation captures achievements, obstacles, and lessons learned. These reflections guide adjustments in subsequent sprints and are stored in the shared repository for transparency. This approach embodies the BI meta-skill *Learn*, turning reflection into active performance improvement.

All BI meta-skills are demonstrated: *Define* through diagnosing reproducibility barriers, *Design* through framework creation, *Execute* through application and validation, *Learn* through iterative reflection, and *Lead* through autonomous project management and ethical stakeholder coordination. The project thus represents a full cycle of academic, professional, and personal development.

Chapter 20. Final Integration and Handover

The project concludes with the full validation of all deliverables through joint review by the client and academic supervisor. Each output is assessed against the criteria of clarity, usability, reproducibility, compliance, and scalability, with all feedback integrated into the final versions. The finalized materials include:

- **Reproducible Research Framework:** Defines the Lab's research stages, responsibilities, and documentation standards.

- **Templates and Checklists Toolkit:** Provides practical tools for planning, recording, and validating research activities.

- **Comparative Evaluation Report:** Demonstrates the framework's effectiveness across nine internal cases.

- **Implementation and Recommendation Brief:** Outlines conditions and steps for institutional adoption of the framework.

- **Reflection and Documentation Log:** Records the research process, decisions, and validation notes for transparency and learning.

All materials are securely archived within Windesheim's research repository for continued institutional use. The final handover confirms that both the client and supervisor are fully equipped to apply the framework and supporting tools in future research cycles. The successful completion of this project provides the Value Chain Hackers Lab with a practical, evidence-based system for improving research quality and continuity, while demonstrating the student's capacity for academic rigor, professional leadership, and applied innovation.

Conclusion

This project proposal outlines an innovative plan to strengthen the Value Chain Hackers Lab by introducing a reproducible framework that transforms fragmented student research into a structured, transparent, and verifiable process. The innovation lies in redesigning the research method itself, embedding international standards such as FAIR, OECD, and Science Europe into a practical system that enables consistent and credible results. Grounded in design science research, the project combines academic rigor with institutional feasibility to improve research quality, traceability, and continuity. By aligning global standards with the Lab's operational needs, it addresses a real institutional challenge while building long-term capacity for learning and improvement. The proposal demonstrates all Business Innovation meta skills by defining a relevant challenge, designing and executing a viable solution, learning through reflection, and leading sustainable change within a real organizational setting.

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