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THE ANATOMY OF A DESIGN CHALLENGE FOR INITIATING AI INNOVATION

Completed Research Paper

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Abstract

Artificial Intelligence (AI) unlocks value-creation opportunities, but its complexity makes it a challenging design material, demanding well-prepared conditions for successful innovation. One reason organisations struggle to materialize AI's potential is initiating AI innovation, which relies on interdisciplinary teams, internal data integration, incremental development, and context information. The Design Challenge, i.e., problem formulation, serves as key artefact guiding AI innovation, but its conceptualisation remains undertheorized leading to a lack of theoretical foundation and practical guidance. Our study conceptualises the Design Challenge as a boundary object enabling interdisciplinary collaboration and serving as a reference point. We performed a qualitative cross-cases analysis of 42 design challenges to surface seven key elements being verb, object of innovation, internal data, technology, target group, context and potential, generating the Design Challenge's anatomy. This advances theoretical understanding of AI innovation and provides a conceptual schema to craft design challenges enhancing the likelihood of impactful AI innovations.

Keywords: Design Challenge, AI Innovation, Boundary Object, Anatomy

1 Introduction

AI innovations offer unique value-creation opportunities, yet initiation for it remains challenging for organisations as AI innovations require interdisciplinary collaboration between Business domain, IT, and Data Science experts (van Giffen & Ludwig, 2023). That can cause friction as it is needed to integrate diverse knowledge, internal data, and context-specific framing but also different methods and mindsets (Lin & Maruping, 2025). AI is challenging to innovate with since it refers not to a distinct set of technologies but an ever-evolving material with emerging characteristics such as greater autonomy, deeper learning capacity, and an inscrutable nature (Berente et al., 2021). We follow the AI definition from a phenomenological view referring to von Krogh (2018) defining AI as an economic and organisational phenomenon building on task inputs, processes, and outputs performing tasks that were usually in need of human cognition.

While the AI innovation process is increasingly studied (Chu et al., 2024; Igna & Venturini, 2023; Sjödin et al., 2021), the conceptualisation of its initiation is undertheorized. Existing research focuses on the processes and methods but neglects theorising the artefact and activities that initiate AI innovation. This is problematic because research lacks a theoretical foundation, so processes and methods are defined in a vacuum. For example, there is a research stream on AI within innovation processes and its capabilities

for specific process steps such as brainstorming or ideation (Gama & Magistretti, 2025; Lazar et al., 2025; Mirkovski et al., 2025; Sjödin et al., 2021). But the design objects that are created or the origin of the initial problem is not described. Another stream focuses more on methods and how to integrate AI in innovation teams on the continuum from tool to teammate (Kosmyna et al., 2025; Ramaul et al., 2025; Siemon et al., 2025). While this provides insights on the collaboration it does not answer questions on how the collaboration is initiated. In many cases of AI innovation, the Design Challenge is the first emerging artefact, also framed as a design briefing, problem statement, or project mandate (Hatchuel & Weil, 2009; Kapkın & Joines, 2021; Parameswaran et al., 2023). It contains relevant information of the problem by stating a question understandable to different stakeholders. At the same time, the Design Challenge provides a frame of the circumstances and the genesis of the problem while hinting into which direction a solution might be.

Although the Design Challenge constitutes a critical artefact at the early stage of AI innovation initiation, it has not been recognised or theorised within the context of AI innovation research (Verganti et al., 2020, 2021). This conceptual absence is an epistemological impediment: without a theoretical conceptualisation of the artefact, researchers lack theoretical guidance on how to systematically approach and frame AI innovation at the early experimental stages. Conceptual opacity makes empirical investigations impossible: phenomena lacking theoretical foundation remain analytically intractable. Consequently, recent research predominantly examined AI innovations retrospectively, foregrounding processes and outcomes (Lin & Maruping, 2025). Developing a theoretical conceptualisation of the artefact Design Challenge is epistemologically necessary to enable research about the initiation and framing of AI innovation. In addition, practitioners might benefit as systematic guidance on how to formulate design challenges that enable impactful AI innovations becomes possible. Addressing the theoretical and practical need for conceptualisation and guidance requires examining the anatomical constitution of this artefact.

The research question for this paper is therefore: *What are the key elements for the anatomy of a Design Challenge initiating AI innovation?*

To address this research question, we conceptualize the Design Challenge as a boundary object building on the theory by Star & Griesemer (1989). Hereby we use the artefact of the Design Challenge as an enabler for interdisciplinary collaboration balancing specificity and generality. We report on a unique cross-sectional structured content analysis based on theory-guided comparative artefact analysis (Gerring, 2006; Mayring, 1994; Orlikowski & Iacono, 2001) of 42 design challenges from corporate AI innovation projects. We identify seven key elements for the Design Challenge, their functions within the innovation activities, and nuances within the elements.

Our analysis reveals four robust elements being *verb*, *object of innovation*, *target group* and *context*, and three plastic elements being *internal data*, *technology* and *potential* building a Design Challenge to initiate AI innovation as a result of interdisciplinary collaboration. The combination of the seven elements is stable enough to guide activities while simultaneously being adaptable to emerging solutions. This characteristic becomes especially important as it accounts for the ever-evolving nature of AI and is helpful for the innovation team. The Design Challenge functions as a bridge through the social worlds of the experts involved and a reference point within innovation activities. This contributes theoretically by advancing the understanding of AI innovation initiation through boundary object theory. Practically, this study provides a tangible schema for generating design challenges structuring the initiation of AI innovation and enhancing the likelihood of generating impactful ones.

This paper is structured as follows. First, we present the conceptual background of AI innovation and the Design Challenge. Second, we present the boundary object theory used to conceptualize the design challenges as such. Third, we develop the anatomy of the Design Challenge from a qualitative cross-sectional case study through comparative theory-guided artefact analysis, resulting in the identification of four robust and three plastic key elements. Finally, we demonstrate how these elements form a tangible schema and their role as centre of authority and reference point in AI innovation activities.

2 Conceptual Background

2.1 AI Innovation

AI innovations appeal through unique opportunities such as human-like cognition, automation or augmentation potentials, and its predictive nature (Rai et al., 2019; Raisch & Krakowski, 2021). At the same time, AI innovations need to overcome managerial, organisational, and cultural challenges, which result from AI's contingent nature (Ångström et al., 2023). Several recent studies have pointed out that especially in AI innovation, collaborative efforts are needed to achieve the innovation team's goal and act purposefully in a coordinated manner (Hopf et al., 2023; Siemon et al., 2025; Verganti et al., 2020). However, these collaborations often come with tensions as methods, mindsets, as well as approaches and vocabularies differ throughout the disciplines. This collaboration at the early stage of AI innovation is in need for the creation and organising of a collective starting point aligned, representative and integrated in all team members' views (van Giffen et al., 2025). Hence, challenges in generating AI innovation emerge from a variety of stakeholders necessarily involved requiring coordination and knowledge integration.

The generation of AI innovation is by nature experimental with its inherent learning requirements and context sensitivity, it often operates as a black box with designer's expectations not rooted in capabilities but in assumptions (Engel et al., 2024; Knotte et al., 2020; van Giffen et al., 2022). Therefore, organisations often lack knowledge about the capabilities AI holds for innovation (Lin & Maruping, 2025). These characteristics leave them incapable of telling what the AI features should or can do as an input factor in their design. Hence, AI innovations are often poorly defined and consistently lead to unsuitable starting points (van den Broek et al., 2021). Another reason is that unrealistic expectations of the technology's capabilities cannot be translated into real-world applications (Lin & Maruping, 2025). These unclear and ever-evolving capabilities make it difficult to formulate what the AI innovation should target as it is a moving target. Accordingly, this requires shifting the focus towards the artefact that lays the foundation for all AI innovation activities influencing the general direction.

AI innovations create various possibilities and solutions that are dynamic and malleable (Yoo et al., 2012). Research from Yoo et al. (2024) has conceptualized AI innovation as process innovation in contrast to digital innovations that tend to be product innovation. Recent research from Lin and Maruping (2025) conceptualised AI innovation along their form (process vs product) and magnitude (incremental vs. radical) (Schumpeter, 1934) and concluded that AI innovations tend to be more incremental and, in line with Yoo et al. (2024), more process-focused. However, focussing on different AI innovation outcomes only misses that AI innovation might have different starting points depending on the actors' intentions and on the framing given to the innovation team. Therefore, the examination of these starting points for AI innovation is necessary to gain a more nuanced and differentiated understanding. This supports shaping the AI innovation ex ante and guiding innovation activities accordingly. The artefact of the Design Challenge as a starting point at the early stage of innovation is therefore an entry point to elicit such nuances.

2.2 The Design Challenge as Initiating Artefact of AI Innovation

The Design Challenge does not describe or specify the targeted (AI) solution but provides information about a problem and its specifications e.g., the targeted user or contextual information. Hence, the Design Challenge is a potentially useful artefact for initiating innovation as it motivates the problem exploration providing directions for potential solutions. As such, the Design Challenge is similar to a research question in academic research or a design brief in design (Agee, 2009; Kapkın & Joines, 2021; Sandberg & Alvesson, 2011). Analogous to a research question that provides structure and shapes the inquiry (Recker, 2021), the Design Challenge structures and shapes innovation activities.

The importance of a Design Challenge is especially given against the background of Generative AI, where the production of solutions is becoming cheaper and doable with a few prompts (Bouschery et al., 2023). Including large language models into the innovation process helps in generating a multitude of ideas in seconds while at the same time supporting the analysis of data and extracting insights that

might be helpful for the innovation activities. Still, humans are needed to initiate the generation with a first prompt that contains the problem or question to be solved (Gama & Magistretti, 2025). However, real value can only be generated with a solid understanding of the problem, i.e., the prompting context (Tolzin et al., 2024). This is achieved through asking the right questions to generate knowledge and precisely problematize it with a holistic and unified understanding throughout the innovation team (Elder & Paul, 1998; Lazar et al., 2025; Marquardt, 2014). This underpins the importance of the Design Challenge as an artefact to enable such an examination of the problem in order to design a solution that generates value (Shollo et al., 2022), purpose and impact. Additionally, this approach reduces solutions using new technologies such as AI without solving the root cause of a given problem or addressing an identified innovation opportunity.

In addition to initiating collaboration, the Design Challenge is understood by teams with various backgrounds. Especially for AI Innovation, where interdisciplinarity is a needed prerequisite for the innovation activities, this feature is necessary. A shared understanding and a common, accessible language that facilitates cooperation must therefore be established at the beginning. The formulation of the Design Challenge leaves room for interpretation from a disciplinary perspective while simultaneously providing guidance. This vague, sometimes even ambiguous formulation is in the context of AI innovation a strength of the Design Challenge (Carleton & Uebernickel, 2025; Dickhaut et al., 2023; van Giffen & Ludwig, 2023).

2.3 Boundary Object Theory as a Lens

Boundary objects are artefacts e.g. an item, construct, or term that acts as centre of authority and reference point in an interdisciplinary collaborating group, creating a common goal and bridging social worlds (Star & Griesemer, 1989). An example given by Star and Griesemer is a “library” (Star & Griesemer, 1989, p. 410), as it is understood by all users, whereas each user can use it differently e.g., to borrow books, as a place to work or relax and read. More IS-related examples would be requirement specifications (Barrett & Oborn, 2010; Levina & Vaast, 2005), published representations of design ideas (Ewenstein & Whyte, 2009; Hendry, 2004), or project management tools (Sapsed & Salter, 2004; Yakura, 2002). These objects are understood by several disciplines and thus provide a joint working space. Through this mechanism, boundary objects satisfy the informational requirements of different disciplines, while making meaning translatable throughout disciplines. Interdisciplinary collaboration becomes possible as different expertise can be exploited while a mutual understanding is given.

The nature of boundary objects is “both plastic enough to adapt to local needs and constraints [...] (and at the same time) robust enough to maintain a common identity across sites” (Star & Griesemer, 1989, p. 393). The combination of both plasticity and robustness in one object enables interdisciplinary collaboration. Still, it balances specificity and generality as the plastic elements are able to emerge over time and robust elements give general information that is stable over time. This is in the literature stated as temporal negotiations of expectations and coordination for the collaboration (Yakura, 2002).

Therefore, the creation and management of boundary objects is “a key process [...] (for realising) coherence across intersecting social worlds” (Star & Griesemer, 1989, p. 393). The prerequisite for the generation of boundary objects is threefold: Sharing a common goal, agreeing to a defined process, and having individual perspectives on the topic while being an expert in a domain.

We use boundary object theory to conceptualize the anatomy of a Design Challenge. That is, to identify the key plastic and robust elements through which the Design Challenge facilitates interdisciplinary collaboration in the context of AI innovation. By proposing a shared challenge as well as bringing different domain experts together to solve the challenge, the theoretical prerequisites for boundary objects are given.

3 Methods

3.1 Research Design

We performed a cross-sectional case study (Gerring, 2006) based on theory-guided comparative artefact analysis to systematically identify and analyse the elements of the anatomy of the Design Challenge in AI innovations. For this, we examined a theory-guided artefact analysis (Mayring, 1994; Orlikowski & Iacono, 2001) of 42 design challenges from corporate AI innovation projects. As a note of guidance, we use Design Challenge capitalized when referring to the artefact and design challenges in small letters when referring to our data. Our objective was to learn from that unique dataset what elements generate the Design Challenges to initiate AI innovation and function as a bridge across stakeholders from different disciplinary backgrounds involved in AI innovation projects. Furthermore, we want to examine how these elements form the anatomy of the Design Challenge to get insights on the balance within this key artefact.

3.2 Case Selection and Data Collection

The study draws on data from a corporate AI Innovation program conducted in collaboration between an AI research lab and corporate partners from a variety of different industries and company sizes (see Table 1). The projects were carried out by innovation teams in close collaboration with corporate partners during 2020 and 2024. The analysed design challenges were crafted by the corporate partners, who engaged within their organisations to discuss and specify their AI innovation objective. These discussions were supported and facilitated from senior researchers of the AI research lab. It was an iterative open process to guarantee it involved all relevant information to understand the described problem. For this exercise no template or further aid was used to guarantee an open process without using conventions of the program context. The corporate partners were usually at an early stage of finding their use of AI for their organisations. This underpins the early innovation stage this process was taking place in. During the innovation activities the senior researchers did not have an active role apart from supporting the innovation teams with process guidance and regular coaching sessions.

Industry cluster	Number of projects	In %	Company size
Financial and insurance activities	13	31.0	39 - 312 000
Manufacturing	12	28.6	142 000 - 312 000
Human health and social work activities	6	14.3	3 - 4 273
Other Service Activities	3	7.1	29 - 200
Information and Communication	2	4.8	19 000
Public Service	2	4.8	3 486 - 62 300
Wholesale and retail	2	4.8	4 000 - 6 120
Electricity, gas, steam and air conditioning supply	1	2.4	3 000
Real estate activities	1	2.4	60
Total	42	100	3 - 312 000

Table 1. Distribution of innovation projects across industries.

Our used dataset consists of 42 projects in total, which were conducted between 2020 and 2024. The 42 cases provide comprehensively documented data including the Design Challenge, which provided the innovation team with initial briefing documents between six and ten pages, as well as the final project documentation. The data was fully anonymized prior to analysis, removing all identifying corporate partners or the innovation team individually.

3.3 Data Analysis

The analysis was conducted by a four-person research team, two being external to the AI research lab, ensuring analytical distance from the innovation context. The coding process unfolded as follows:

As a first step for the analysis, all four researchers independently coded the complete dataset of 42 projects, focusing on extracting elements of the Design Challenge from briefing documents and final documentation. The coding was conducted manually, allowing for flexible and close engagement with the substantial document corpus. This initial coding generated inductive preliminary codes capturing (1) various verbs as the operator or guideline to the innovation activities such as *optimize*, *scale*, *make*, *support* within the challenges, (2) internal and external target group references such as *finance domain experts*, *young men or our internal teams*, and (3) contextual information such as *making it self-explainable* or *keeping the personal effort to a minimum* which conveys information not only about the context but also about attributes the solution should have. In addition, the four researchers began to deductively include codes drawn from literature to describe the Design Challenge's function resulting in one preliminary code, the *use as success criterion*. As a second step the researchers conducted a "consensus and sensemaking meeting" to discuss discrepancies and refine the coding schema through systematic comparison. This process ensured coherence for the analysis across the team. A second round of selective coding followed to apply codes like *operator*, *context* and *potential*, as well as reference to *internal data* or *technology* more systematically and identify patterns across cases. Particular attention was paid to the manifestation and variation of emerging codes and their relationship to each other. Theoretical saturation was reached after analysing between 30 and 35 projects depending on the researcher, with the final seven codes confirming established patterns without revealing new dimensions. Through this iterative process we found theoretical saturation and defined "abstract variables and their relationships" (Wiesche et al., 2017, p. 687) to generate the Design Challenge anatomy as a result. As a last step, each researcher conducted a review of their complete coding, ensuring internal consistency within their individual work. A final consensus and sensemaking meeting were conducted resolving the remaining minor discrepancies to full agreement through discussion, in line with the interpretive tradition in qualitative research (Tracy, 2010). This included finalizing the *context* and *potential* as two independent codes well as *object of design* and *verb*. This iterative process resulted in seven final codes organised into two core categories being robust and plastic elements that build the Design Challenge anatomy.

4 Results

4.1 Anatomy of the Design Challenge

Our analysis surfaced four robust (*verb*, *object of innovation*, *target group*, and *context*) and three plastic elements (*internal data*, *reference to technology*, and *potential*) that build the Design Challenge anatomy (see Figure 1). We note that these key elements, especially the plastic ones, were used in variations in the examined design challenges. Still, the key elements form not only a linguistically correct question to work upon but convey all relevant information for the innovation team. The sequence of elements in the anatomy follows the most frequent pattern extracted but is capable of variations especially through the flexible nature of the plastic elements.

Figure 2 depicts the anatomy of a Design Challenge applied to one of our cases from the dataset. Seen in an applied form, the advantages of the anatomy become clear: the Design Challenge provides the right amount of specific information without being overly detailed. The given example from a corporate bank conveys within one question the information needed to understand the overall context while being guided to the main object of action. In this example, it is the *customer experience* of the corporate bank. This balance of specification and generalization is achieved through the combination of four *robust* and three *plastic* elements in the Design Challenge's anatomy. The robust elements create a shared understanding as they are understandable regardless of the disciplinary backgrounds. Hence the general topic is conveyed throughout the team. The plastic elements leave room for interpretation and exploration to enable open innovation activities. In addition, it becomes easier to formulate a Design Challenge, once we know the key elements of the Design Challenge.

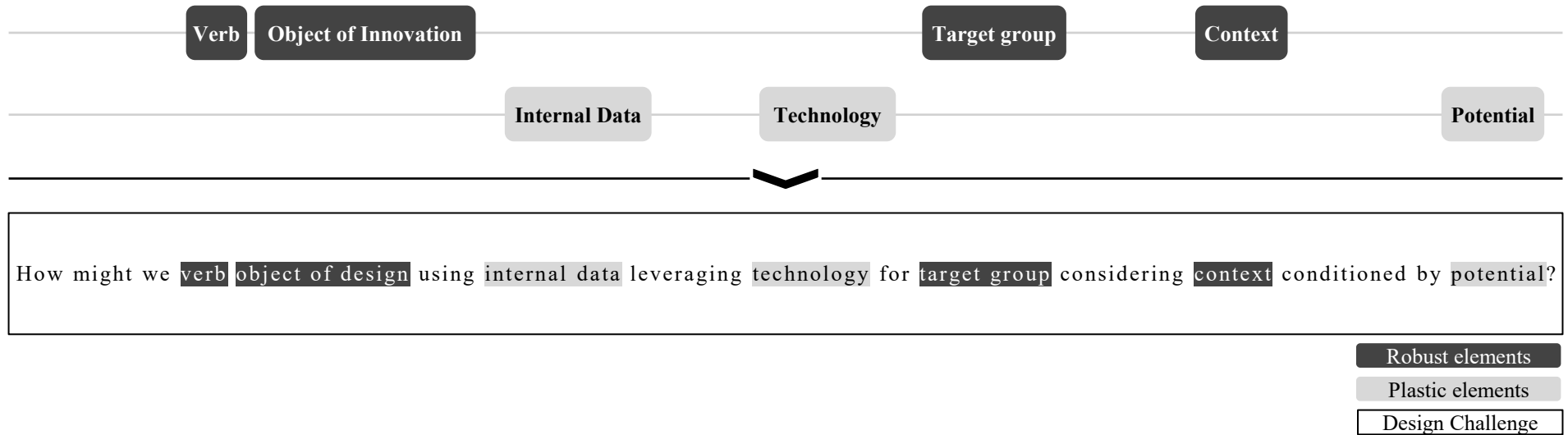


Figure 1. The anatomy of the Design Challenge.

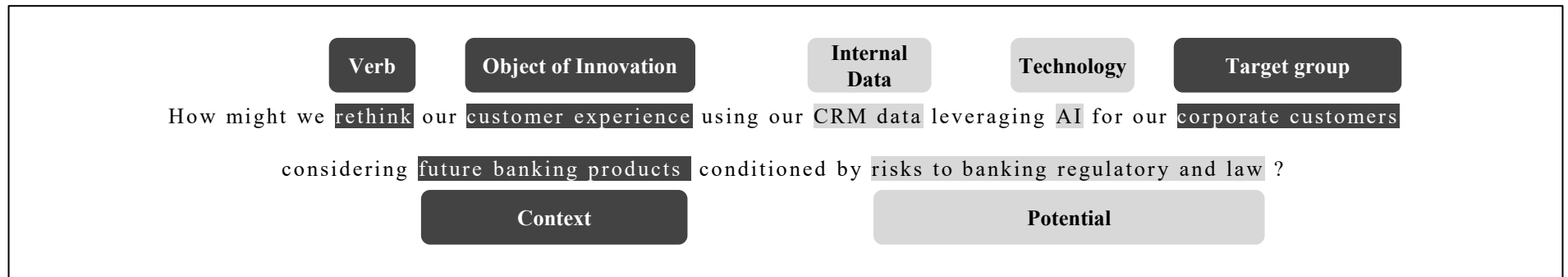


Figure 2. Example of a design challenge including the key elements of the Design Challenge anatomy.

We identified four *robust* elements of the Design Challenge anatomy: *verb* to guide the AI innovation activities, *object of innovation* to clarify the object of work, *target group* to clarify whom the AI innovation is targeting and *context* to explain the environment in which the AI innovation is situated.

For the operator that is used within the Design Challenge, we see a wide range of *verbs* from *rethinking* (e.g. case #4), *redesign* (e.g. cases #13-15), to *accelerate* (e.g. case #6), *increase* (e.g. case #24), or *enhance* (e.g. case #32). All have in common to guide the activities in terms of their nature including to either neglect previous activities or to build upon them. The *objective of innovation* is usually the object that is the centre of action during the innovation activities. These vary greatly from *care journeys in hair treatment* (e.g. case #5) over *soccer fan experiences* (e.g. case #32) to *onboarding processes* (e.g. case #6) and *marketplaces* (e.g. case #13) or *IT initiatives* (e.g. case #15) depending on the context and company. The beneficiary of the innovation is always stated within the *target group*. In our analysis we found both, internal and external target groups. It was referred to e.g., *employees* (e.g. case #1), *domain experts* (e.g. case #3), *customers* (e.g. case #4) or *single-family homeowners* (e.g. case #10). Looking at the different examples stated, the different groups shed light on possible needs to be solved with the innovation. The environment within the innovation activities take place is stated in the *context*. Examples for *contexts* given are such as *energy-efficient living* (e.g. case #10), *sparkling value and excitement in use* (e.g. case #13) or *offering the best customer experience* (e.g. case #1). This way, the environment in which the potential solution is situated is not opaque to the innovation team. It provides a tangible idea although coming from an outside-in-perspective as an external innovation team. These four elements are robust and given in all of the 42 cases analysed. The robustness makes these elements stable over time and understandable regardless of the expertise of the actors. This is as the boundary object theory explains the reason why interdisciplinary collaboration is possible. In addition, this shared understanding of the problem and of a possible solution in a specific direction, anchors and unifies the innovation team with a shared identity.

We identified three *plastic* elements of the Design Challenge anatomy: *Internal Data* as the internal inputs of a company given to the innovation team, *Technology* as the technology input factor and *Potential* as a frame in terms of opportunities and risks related to the AI innovation.

The internal input, which can be seen as additional supporting working material given to the team, presents the status of the company's work on the given topic. Examples for *internal data* are *our overall process landscape* (e.g. case #9), *use our existing data* (e.g. case #29), or *energy data from our machines* (e.g. case #10) and convey that this adds additional context and information about the internal structure and process organisation of the company. *Technology* is stated as a direct reference to a specific technological solution envisioned for the innovation initiative. We found examples such as *AI* (e.g. cases #5-6), *AI possibilities* (e.g. case #3), *AI technologies* (e.g. case #19), or *new technologies and AI* (e.g. case #11). While this reference seems like a duplicate, as the overall context of the design challenges are AI innovations, the extra reference emphasizes that the use of specific technologies is envisaged for solving the design challenge. The frame which is the last plastic object within the anatomy focuses more on the *potential* that is seen for the design challenge. Having *considering new emerging opportunities* (e.g. case #14), *opportunities provided* (e.g. case #28), or *potential of value-added* (e.g. case #24) stated in the design challenges, it adds an evaluative perspective to the Design Challenge for the team. The plasticity of the elements makes the challenge actionable as they can emerge in line with the project timeline. Due to the openness of the elements, they can be negotiated within the innovation team which is helpful when discussing possible solutions.

Building the anatomy of the Design Challenge, we linked the elements with typically used words. The opening of the design challenges was usually “*How might we*” as a term often used in innovation activities (Berger, 2012) to turn broad insights from various backgrounds into a jumpstart for solutions (Stremersch, 2024). This open formulation fulfils a twofold purpose: opening the challenge with a question, not a statement, instantly sparks ideas and opening with a broad tone in the questioning includes multiple ideas and perspectives. In addition, the Design Challenge closes with a question mark to formally indicate a real question. References to *internal data* and *technology* were given with the words “*using*” and “*leveraging*” to signal the innovation team what further resources are available to consider. To describe the *context* and include *potential* that reflects both, opportunities and risks the

typical words are “*considering*” and “*conditioned by*”. Table 2 illustrates the key elements in their nature with their function within the Design Challenge and further examples from our dataset.

Key element	Function in Design Challenge	Worked example using the anatomy	
<i>Elicited element from the analysis conducted.</i>	<i>Description of the elements function within the Design Challenge for AI innovation.</i>	<i>The two examples are real anonymized examples from the dataset, slightly reformulated to follow the anatomy in terms of the order of elements.</i>	
		<i>Example one</i>	<i>Example two</i>
<i>How might we</i>	Broad opening	How might we	How might we
<i>Verb</i>	Operator	optimize	redesign
<i>Object of Innovation</i>	Object of Design	the data processing and information flow	negotiation trainings
<i>Internal Data</i>	Internal Resources	using our process standards	using our current user experience
<i>Technology</i>	Technology Input	and new technologies	and AI
<i>Target group</i>	Beneficiary of Innovation	For our company	for our employees
<i>Context</i>	Environment of Innovation	considering operational efficiency	defining new business opportunities
<i>Potential</i>	Frame for Innovation	conditioned by quality assurance?	conditioned by limited resources?
<i>?</i>	Indicating the question formally	<i>?</i>	<i>?</i>

Table 2. *Robust and plastic elements in the Design Challenge balancing generality and specificity and their function within the Design Challenge.*

4.2 Design Challenge Elements and their Use in AI Innovation Activities

We assess the use of the Design Challenge and its key elements to elicit the function it provides within AI innovation activities. This relates to the research question to solidify the key elements by controlling for their influence in AI innovation activities. As a boundary object, the Design Challenge initiates AI innovation by forming the innovation team and proposing a common goal to work upon. To this end, design challenges tend to be formulated openly for interpretation within the AI innovation context. Still, the Design Challenge creates a reference point and common understanding of the starting point and in which direction the team can start working. It transports information stating the problem, the target group as well as the context. Hence the setup of working conditions and an organising logic for the given topic is supported by the information provided.

During early-stage activities in AI innovation, the Design Challenge is deconstructed and analysed to grasp a deep understanding of the need and the root cause of the challenge. We saw this activity of *Design Challenge deconstruction* in every project used for deeper and unified problem understanding within the team. In this activity the Design Challenge is the object of work. This underlines the reference point function that guides the innovation activities.

During later stage activities in AI innovation, like *ideation* or *idea generation*, the Design Challenge serves a different function. Whereas these activities are characterized by divergent thinking, activities and tasks to generate a lot of ideas, the Design Challenge was used as the guideline or anchor that holds the team together. Although it is necessary to diverge at this point, the Design Challenge performs as an authority that needs to be complied with. The open formulation of the Design Challenge is at the same time robust enough to create a frame that allows divergent thinking in an aligned direction. This authority and anchoring function is of importance to get a vast amount of diverse ideas while at the same time having the possibility to realign and redirect the activities to an impactful solution for the Design Challenge at some stage.

In *testing* activities, the Design Challenge is mentioned to verify the ideas and prototypes for their qualities. For the *final solution*, the Design Challenge is the quality gate the solution needs to pass.

The Design Challenge, therefore, not only initiates the innovation activities, but also functions as a reference point throughout most of the activities, as a centre of authority in divergent thinking and a quality gate for the developed solution.

4.3 Nuances within the Anatomy Shaping the *Object of Innovation*

While we focused on the general validity of the elements in the Design Challenge in the analysis phase, we found nuances in the *object of innovation* in the second step. Having coded the object of innovation with characteristics, we found three types: *modular*, *abstract* and *space* (see Figure 3).

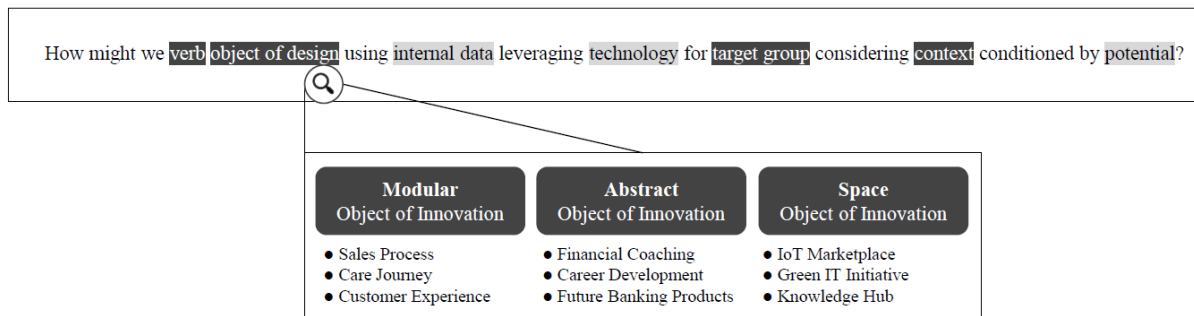


Figure 3. Nuances of the Object of Innovation.

“Modular objects of innovation” include a sense of divisibility in the terms used, such as *Sales Process* (case #22), *Care Journey* (case #5), or *Customer Experience* (case #21). The terms include smaller pieces or steps that can be focused on. The design challenge from a hair loss treatment company: *How might we design a care journey for hair loss management using AI for young men between 20-35 considering the overall care routine?* shows this fragmentation. As the journey can be cut into pieces, it invites stakeholder groups to include their individual knowledge in the innovation activities.

“Abstract objects of innovation” used terms that transport the nature of the object as being not yet fully clear or expressible. Terms like *Financial Coaching* (case #4), *Career Development* (case #19), or *Future banking products* (case #36) vaguely state what is meant or aimed for. At the same time, they leave room for further concretising within a possible solution. The example from an automotive case depicts the essence of it: *How might we re-imagine career development leveraging the opportunities provided by AI technology for young professionals considering the given current challenges in automotive?*. Career development as the *object of innovation* is understood but stays abstract leaving the innovation team with the task to make these *developments* more concrete in their solution.

By “space of innovation” we refer to a defined frame that sets the boundaries for a potential solution while keeping its content open-ended. Such spaces clarify where innovation should emerge, without specifying the outcome. Terms like *IoT Marketplace* (e.g. cases #13, #22, #26), *Green IT Initiative* (case #15), or *Knowledge Hub* (case #35) are examples that represent those spaces while inviting innovation activities to create content for them. For example, a manufacturing company asked: *How might we redesign the ‘Green IT’ initiative leveraging the opportunities provided by AI technologies for our employees conditioned by our green procurement policies?*. This question illustrates how AI innovation is intended to emerge within the established initiative.

Although all of them act within the anatomy as the *object of innovation*, they shape the innovation activities in different directions:

- Modular focusing on generating new ideas that build in an incremental way to the greater object of innovation. The term inherits that modularity directly (i.e. case #5, care journey). This might have an influence on the final AI innovation as it might be more incremental with such an object of innovation.

- Abstract by making an abstract challenge more concrete through the innovation activities. This nature is directly included in the abstract object of innovation (i.e. case #19, career development). This might lead to increased clarity for what to aim for with AI innovations.
- Space focussing on bringing content to a given innovation space (i.e. case #15 Green IT initiative). That is inherent in the space object of innovation. This might lead to more radical innovations as the content is open-ended and therefore more open to radical new ideas.

5 Discussion

We analysed the key elements and conceptualized the anatomy of a Design Challenge for AI innovation. Based on 42 corporate initiatives, we identified four robust and three plastic elements to build impactful Design Challenges balancing specificity and generality to initiate AI innovation.

5.1 The Design Challenge Elements and their AI Specificity

The four robust elements – *verb*, *object*, *target group* and *context* – constitute the shared identity across the innovation team. Their function is generalisation: The combination of these elements is clarifying the what of the AI innovation initiative, without prescribing how the AI innovation is done. This distinction is consequential for AI innovations as a premature commitment to a solution architecture or technology configuration would redirect the team attention from problem definition to capability demonstrations and ultimately lead to a central failure mode of AI enterprise AI initiatives (Davenport & Ronanki, 2018). Therefore, the nature of the Design Challenge as an open question anchoring and problem statement is taking the ever-changing nature of AI into account. The robust elements create a stable surface against which the innovation team can coordinate their activities without the requirement of having a consensus on the underlying AI capabilities and assumptions upfront.

In addition, the robust elements establish an innovation corridor: the loose problem description within the AI innovation activities and the exploration take place. By doing so, the robust elements provide governance for the autonomous, learning and inscrutable nature of AI (Berente et al., 2021). Because AI can produce outputs that are difficult to anticipate in advance, the innovation teams face the risk that iterative experimentation progressively detaches from the original innovation intent as the capabilities of AI develop. The robust elements counteract this by functioning as the centre of authority (Star & Griesemer, 1989). This simultaneously stimulates expectation management.

The three plastic elements – *resources*, *technology* and *potential* – are adaptable to the given context of the company but also to the disciplines involved in the innovation team. Their function is specification: The combination of these elements is providing a scaffold for the collaboration without losing interpretive freedom that AI innovation requires. The innovation team works under the working definition of AI being malleable and open for change as well as being emergent (Nambisan et al., 2017; Yoo et al., 2010). Hence, standard planning artefacts or requirement lists do not account for this and are after a time not useful for the innovation teams. The plastic elements of the Design Challenge do account for these emergent features by being emergent and interpretable themselves. By this nature they can account for the probabilistic behaviour of AI (Engel et al., 2024).

The plastic elements respond to the nature of AI as an uncertainty absorber: by providing structured elements in which the AI's capabilities can be iteratively discussed and renegotiated across the team. The technology element, hence, can be viewed as an ongoing discussion and assessment of what the AI could contribute to the given problem context (Lyytinen et al., 2016). The Design Challenge therefore tolerates and actively organizes for uncertainty. In addition, each discipline within the innovation team can contribute their own expertise in these discussions without being constrained by a fixed specification. This transforms the Design Challenge into a living coordination device supporting the translation of knowledge across boundaries (Star & Griesemer, 1989).

Together, the robust and plastic elements balance generalisation and specification for the innovation team (figure 4). Whereas the robust elements hold a shared problem description that enables collaboration persistent over iterations, the plastic elements absorb uncertainty which is constitutive of

AI. This balance positions the Design Challenge as a reference point, centre of authority, and quality gate enabling productive AI innovation activities despite the technological uncertainty that organisations cannot fully resolve in advance.

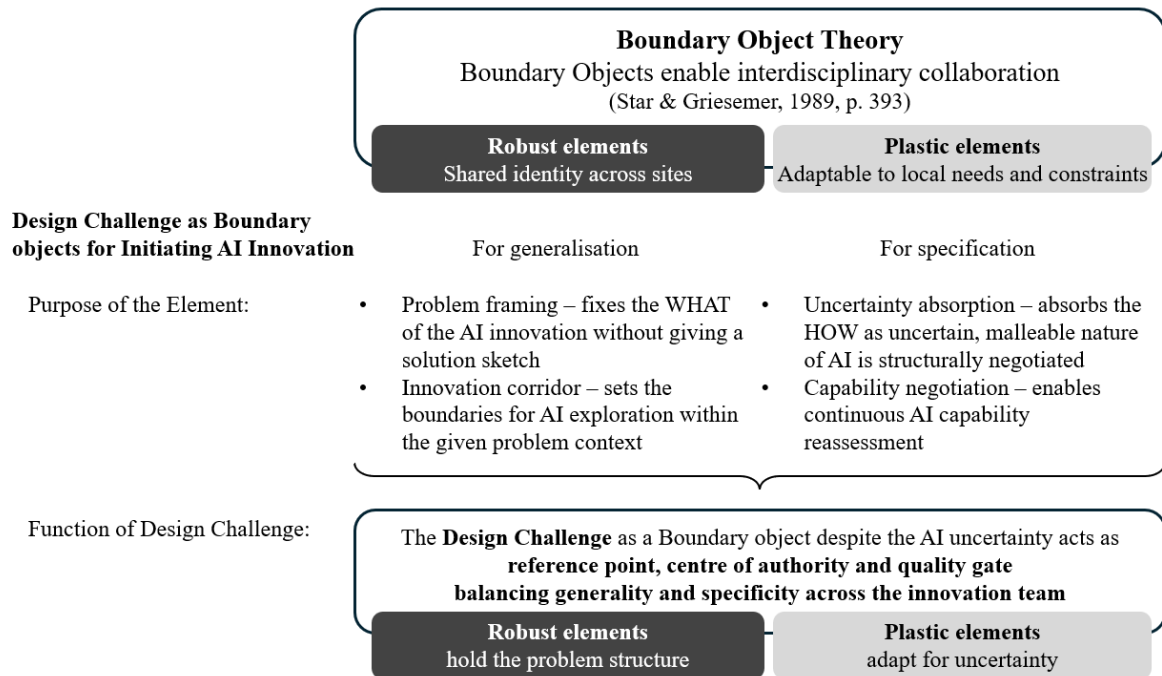


Figure 4. The Design Challenge as a Boundary Object for Initiating AI innovation.

5.2 The Design Challenge Elements and their implications for the AI Innovation activities

The stability of the robust elements brings safety and guidance for the innovation team collaborating in an unclear setting. This enables the team to align on the overall direction and enable collaboration although some working features are not clearly defined. The key elements and their functions contribute to research on the dynamics within the innovation activities (Igna & Venturini, 2023) by providing first insights on the needs of involved stakeholders.

The flexibility of the plastic elements enables the adaptation of the challenge as the newly generated innovation emerges, giving the innovation team freedom to ideate and think together apart in divergent activities but also to discuss AI's capabilities upfront. Through these elements, it is possible to remain open to new ideas and activities emerging from the conduction of innovation activities (Barrett et al., 2012; Carlile, 2002). By these means, we also contribute to the on-going challenge in deciphering the problem space when designing IT artifacts (vom Brocke et al., 2020).

The proposed theoretical lens of the Design Challenge as boundary objects in innovation activities (Ewenstein & Whyte, 2009; Star & Griesemer, 1989) helps to examine its use as a core artefact. The Design Challenge has significant impact on the AI innovation itself and significant impact potential on the organising logic in AI innovation activities. Especially in divergent activities with different disciplinary approaches, it acts as the central element embodying a shared goal and a common direction. Therefore, it serves as an acknowledged reference point from and within every discipline, contributing to the importance of common ground in innovation activities (Dickhaut et al., 2023).

Focusing on the functions the Design Challenge pursues, it is a principle for innovation activities. The Design Challenge refers to the perspective and philosophy shaping the innovation activities by informing the act of designing and constituting what the design is ontologically for (Verganti et al., 2020). For the overall innovation activities, the Design Challenge is used as the quality gate,

incorporating the conditions that need to be met. This leads back to the comparison with a research question for the research process. Being at the early stage of AI innovation, the question stated shapes the activities and to some extent already includes the solution (Recker, 2021). This hinge function is in essence the bridging of social worlds, the initiation of collaboration, and the iterative representation of information needed within innovation activities. This supports the boundary object theory in IS context by providing empirical observations with rich descriptions (Wiesche et al., 2017), advancing the practical relevance of the theory in AI innovation research.

The different nuances in the *object of innovation* shade light on different starting points and their influence on the course of innovation activities. Patterns, such as abstraction, modularity, and spaces are used as a guideline shaping the envisioned solution. First relations from the terms towards the direction of the innovation activities emerge and can also guide practitioners to carefully select terms supporting the expected early core solution idea. This carefulness holds true for all terms used in the schema provided in practice. The elements of the schema provide a scaffold for practitioners to be filled with pointed terms that have been iteratively shaped by the organization. This contributes not only to practice but also shading light on the importance of the formulation of the Design Challenge.

6 Conclusion

The proposed anatomy of the Design Challenge sheds light on the necessary elements for AI innovations. Gaining a deeper understanding on these elements included in the formulation of the artefact initiating AI innovations supports a pointed use of terms and words. This not only helps to understand the function the Design Challenge fulfils during innovation activities but works as a blueprint for practitioners to formulate a Design Challenge that increases the likelihood of generating impactful AI innovation. From a theoretical contribution the anatomy and its elements support a deeper understanding for organizing and initiating AI innovations. Knowing what elements build the Design Challenge supports in generating suitable starting points for AI Innovations ex ante. This translates into a practical contribution as the anatomy can be used as a schema to formulate such starting points in the given context of the organization.

As with any research, this study has limitations that future work can address. While extracting the key elements of the anatomy, we focused on elements that we could trace in our data, neglecting instances that would harm an emerging pattern. While this is natural in the eliciting process, one could further examine design challenges that do not follow the anatomy or omit one of the elements of our proposed anatomy. Having answers to these instances could help in solidifying the proposed anatomy.

Having worked with academic rigor and accuracy, the presented data was conducted under laboratory-like conditions, being supported by coaching and guidance from senior researchers. This might be applicable for most transfer innovation projects that include a scientific partner. The activities conducted when working in a corporate innovation environment without such scientific support might differ. The study therefore lacks this “real-world” empirical view on the anatomy and its functions which might have an impact on the transferability of the results. It might be a fruitful avenue for future research to verify the anatomy under those more conditions.

Apart from the aspects mentioned the topic provides additional perspectives. The different nuances of the *object of innovation* within the formulation underline the importance and impact of the terms used. As patterns emerged it might be interesting to put them into perspective to the type of innovation they shape. As the current research suggests for AI innovations to be incremental and process-oriented, it would be beneficial if future research examined a more nuanced understanding of the influence on form and magnitude of AI innovation that might be possible. Another avenue of research could include a temporal view on the artefact throughout the innovation process. Whereas this research has focussed on the functions of the artefact within innovation activities, having a processual view on the artefact could help to understand the full potential of the Design Challenge in AI innovation.

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