Data Product Canvas: A visual inquiry tool supporting data product design

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Abstract. Data products (DP) are considered a key enabler of data-driven innovation. However, suitable methodologies and tools supporting DP design are still scarce. The emerging body of practitioner literature mostly focuses on analytics-based products and their technical design and architecture but lacks a more comprehensive product perspective on data. To address this gap, we propose the Data Product Canvas (DPC) as a visual inquiry tool that supports cross-functional teams in understanding, designing, and analyzing DPs. The DPC was developed in an iterative design science process involving focus groups with 15 global companies and demonstrations for selected DPs. Building on the core ideas of the Business Model Canvas, the DPC outlines the critical elements for designing DPs around three key themes: desirability from the customer perspective, feasibility from the technical perspective and viability from an economic perspective. The DPC instantiates the design principles for visual inquiry tools and comprises a conceptual model, shared visualization, and directions for use. The DPC is the first step towards a systematic approach and shared language to design DPs in ways that technical experts and business users understand.

Keywords: Visual Inquiry Tools, Data Product Canvas, Data Product Design

1 Introduction

Recent forecasts depict that the amount of data is expected to exceed the 175 zettabyte mark by 2025 [1]. By acquiring these data, analyzing and using them in various assignments enterprises are able to create business value and foster data-driven innovations [2]. When data comes in different forms, combining, packaging and delivering data as a DP allows to create value by fulfilling end users' information needs [3]. DPs can come in various forms and features, such as datasets, lists, metrics, ML models or data-driven physical products [3]. However, high volume of data leads to increasing burden on analytics, lower data reuse and unclear ownership [4] – implying the need to design DPs in a way that facilitates effective consumption and governance. As stated in one of the earlier papers, "*data products aren't about the data; they're about enabling their users to do whatever they want, which most often has little to do with data*" [3].

DPs have recently been popularized by the data mesh concept which encourages domain teams to build DPs as a way to scale analytics and ensure responsibilities and

ownership [4]. Here, DPs are associated with the so-called DATSIS principles and should be discoverable, addressable, trustworthy, self-describing, interoperable, and secure. Building on these ideas, the emerging body of literature on DPs [5, 6] mostly focuses on the technical design and architecture of analytics-based DPs.

Hence, harmonizing the technical and business perspectives to build appropriate DPs remains a challenge [7]. [8] emphasize that the creation of DPs should commence with a broad conceptualization phase involving the collaboration of relevant subject-matter experts prior to any data collection activities. To date, we lack suitable methodologies and tools that could help the different stakeholders – business, data and IT experts – to collaborate in DP design. Therefore, we propose the following research question: *How to support organizations in designing data products?*

To answer this question, we propose the DPC, as visual inquiry tool that facilitates DP design by marrying the technical and business perspectives. The DPC was developed following a design science research (DSR) approach [9], with 15+ global companies involving two design iterations, three focus groups, three demonstrations and two expert evaluations. Building on the core ideas of the Business Model Canvas (BMC) [10], the DPC outlines the critical elements for designing DPs around three key themes: desirability from the customer perspective, feasibility from the technical perspective and viability from an economic perspective. The DPC also instantiates the design principles for visual inquiry tools which comprises of the conceptual model, shared visualization, and directions for use.

The remaining of the paper is structured as follows: section 2 provides a background on DPs and visual inquiry tools, section 3 outlines the methodology, section 4 describes all the building blocks of the DPC and section 5 provides a demonstration of the DPC.

2 Background

2.1 Evolution of data products

Although DPs have become recently very popular [8], it is worth noting that the product perspective on information was already introduced more than three decades ago in seminal papers on data quality management. Drawing the analogy to a manufacturing supply chain, Richard Wang from MIT and his co-authors [11] argued that data moves through an information supply chain where it undergoes several transformation processes to reach end consumers in the form of an information product (IP). They suggested four principles for treating information as a product: (1) understanding consumers' information needs, (2) manage well-defined production processes, (3) manage the lifecycle of information products, and (4) appoint an IP manager to manage the processes and the product [11]. IP have been studied in multiple contexts [12–14], such as data supply chain. In the early understanding, they were mostly associated with information in a tangible form that fulfills simple end-user needs, such as bank statements, with a finite scope and only a limited amount of information.

In the 2010s, the notion of data-driven enterprises gained traction and the term DP gained precedence [3]. In one of the first papers asserting this term, [3] highlight that a

DP should be designed such that consumers can use it without understanding its intricacies. Depending on the need, broadly two types of DPs exist: *overt* DPs where data itself is the output (such as spreadsheets, lists) and *covert* DPs where data is invisible and works in the background (such as recommendation engines) [3, 15]. To enable good design practice around DPs, [7] suggested using the drivetrain approach – a systematic design method to couple business needs and analytical methods to produce actionable output for data consumers. However, this method is very data science centric.

As the need for sophisticated approaches to create more value from data emerged, more analytics-based DPs came to the fore. For instance, [8] argued that Google Analytics Dashboard is a DP offering descriptive insights whereas Predictive Maintenance is a software-based DP that provide predictive insights. They further argue that certain DPs can also be delivered as mobile applications with some level of analytics in the background. On the other hand, more advanced DPs are driven by analytical techniques (eg: regression, classification or clustering) [15] to instill self-learning capabilities and facilitate prescriptive knowledge creation. In addition to the technical aspects, successful DP creation also involves skills around data management, DP design as well as data visualization to impart hidden patterns to end-users through creative data storytelling [16]. Therefore, such analytics-based DPs facilitate decision support across the wider enterprise and hence, its design should include a proper conceptualization stage involving all stakeholders prior to initiating any ETL activities [8]. For this, [17] proposed intersecting the value proposition design framework [18] with analytical techniques as a starting point to design DPs.

Table 1. Data product examples in the literature

Source	Data product example	Data product form
[19] [12] [20] [13] [21] [14]	Client account data, certificates, bills, transcripts, bank statements, invoices, business reports, prescriptions, birth certificate, mailing labels, sales orders, news products	Paper-based
[3, 5, 22, 23]	Spreadsheets, monetizable datasets, raw data, domain sales data, online profit data, personal data, financial data, pharmaceutical data	Dataset
[5, 8, 17]	KPIs, metrices, reports, insights	Dashboard
[3, 5, 8, 15]	Recommendation engines, ML models, predictive maintenance, property price prediction, APIs, 'Quantified self'	Algorithm-based
[3, 6]	Self-driving cars, nest thermostat, autonomous devices	Data-driven physical products

More recently, the data mesh concept has pushed the design of DPs towards the domains that are responsible for the creation and management of their respective data [4]. The underlying principles that drive the DP design thinking in a data mesh environment are the DATSIS principles. [4] argues that such characteristics ensure the creation of high-quality DPs that are well governed and have a higher possibility of meet-

ing stakeholder needs, both externally and internally. Hence, recent practitioner publications have adopted a technical-focused view of DPs [24, 25]. Academically, DPs have been investigated from other lenses, such as service science [17] or data marketplace [26]. Thus, overall, we observe that DPs can come in various shapes, looks and sizes to address the diversity of use-cases data consumers have (Table 1). Nonetheless, common guidelines that underpin the design of these DPs are lacking. More specifically, there is a need to combine the technical outlook with the user-centric product view on data and integrate economic perspectives to ensure a proper DP design.

2.2 Visual inquiry tools as part of joint inquiry techniques

Given the challenges in designing DPs, visual inquiry tools appear as suitable approaches to support DP design. They have emerged as a popular choice in design thinking by leveraging joint inquiry techniques. Joint inquiry techniques allow for an iterative process through which many individuals are able to collaboratively define, explore and evaluate potential solutions to a particular problem [27]. Such techniques motivate cross-functional teams to cooperate and align on a certain topic in a creative manner [27], offering a problem-solving mechanism through which firms can foster innovation and value creation [28]. Visual inquiry tools help organizations navigate a wicked and difficult strategic management problem through providing a shared and framed design space where practitioners can brainstorm together [27]. Some best-known examples are the BMC [10], Value Proposition Canvas [18] and Team Alignment Map [29]. More specifically, these tools allow an alternative way to handle complex management issues by building prototypes that are iteratively improved to capture all design requirements [27]. As a result, they help manifest abstract and uncertain challenges in a tangible form to allow practitioners to find solutions to situations for which there are no straightforward answers [30]. The BMC, for instance, highlights the economic, operational and managerial elements of a business model and provides utility by "*describing the business logic of an idea, product and service in a simple and visual representation*" [31].

When it comes to DP design, we observe an increasing number of canvases, mostly from practitioners [24, 25]. However, they are mainly focused on analytics and emphasize the technical design of DPs. They also lack a thorough theoretical foundation. In the academic literature, only a recent work by [5] developed a canvas related to DP. Firstly, the canvas is analytics-oriented focusing on the type of techniques to be used for the DP. Secondly, the business and economic aspect is missing – elements that are critical to any product development process [32]. Thirdly, the development of the canvas is not grounded on established design principles for visual inquiry tools, rendering it less academically rigorous. Hence, we see an opportunity to create visual inquiry tools for DP design, that integrate the different perspectives of DP design and follow the design principles for visual inquiry tools outlined in [27] – *conceptual model* to structure and describe the building blocks of the problem, *shared visualization* to facilitate communication between users using a visual problem space and *directions for use* to define and specify techniques to allow for joint inquiry.

3 Methodology

3.1 Research methodology and process

In order to develop the DPC as visual inquiry tool, we engaged in a DSR project over a period of eight months between May 2022 – December 2022. The DSR setting allows researchers to collaborate on research problems with practitioners, drawing common ground between rigor and relevance and creating a solution that is practically meaningful and academically sound [33]. Our approach is also consistent with the work of [34] where the proposed cycles of diagnosis, design and implementation coincides with DSR phases, allowing for various entry points. In our case, the research team (consisting of a PhD student and a senior researcher) collaborated with more than 30 experts from 15 global companies, all with significant professional experience in the field of data management and strong overview into the data initiatives in their organizations. The firms are members of a research consortium, alongside the research team, that engage in industry-research collaboration and are part of the research program on DPs. Following the DSR process outlined by [9], we started with the *problem identification*. During our initial focus group with 18 data experts from 12 companies conducted on May 2022, we observed that there is a growing concern around the large volumes of data being created within the organizations or captured from external sources. More specifically, data consumers find it difficult to discover, repurpose and reuse such data in analytical workflows to drive novel use-cases and take the right decision. Thus, a way to uncover the consumer needs to foster a better product-market fit for DPs is required. Additionally, challenges around ownership of the data, access provision and compliance persist. These issues further inflate due to the size and global dispersity of the enterprises, leading to a lack of harmonized approach in managing these data resources. Building DPs were discerned to be one way to deal with these challenges and enhance the reuse of data. The practitioners confirmed the view that DPs allow data governance to be streamlined with clear roles, responsibilities, and tasks [35], leading to high quality data and value generation from driving novel use-cases [4]. However, clear guidelines on how to design such DPs for the consumption of a wide variety of users are missing. Therefore, the *objective of the solution* would be to facilitate conceptualization of DPs using a simple visual brainstorming space which blends both the technical, business and user perspectives on DP. Concretely, the participants agreed to create a canvas that will foster fruitful interaction between various key stakeholders to contribute towards the design of a DP. We named this canvas the DPC. As its goal is to support the design of DPs in organizations, our artifact falls into the theory type V (theory for design and action) of Gregor's taxonomy of IS research [36].

The *first design phase* took place between June 2022 – September 2022, resulting in a first version of the DPC. To inform our design, we scanned both the academic and practitioner literatures existing around DPs and visual inquiry tools. Although few studies highlighted the definition and examples of DPs from a specific lens, such as data science [6] or data marketplace [26], there was an absence of research discussing the design of DPs. Interestingly, we came across few canvases in non-academic publica-

tions [24, 25] that claimed to support the process of DP design. Upon inquiry, we uncovered that such canvases are analytics-driven with heavy focus on the technical aspects of the DP. As they are mainly practitioner-oriented, there is also an absence of academic rigor in their formulation. Our adoption of the product-perspective on data calls for going beyond the technical design elements to explicitly cover the consumer and economic perspectives. They capture the perceived value of the consumers in regard to the DP and outline cost-benefit analysis – both of which play a critical role in deciding whether to invest in a DP. The high-level DPC design was inspired by the BMC [37] and by design thinking tools and methods [31] that outline three spaces – desirability (as the user perspective), feasibility (as the technical perspective) and viability (as the economic perspective) – that should be addressed in innovation. These perspectives and the BMC building blocks are also widely discussed in the product design and development literature [32, 38] and are relevant for DPs. Therefore, we revisited the building blocks of the BMC and adapted them to the context of DPs. For each block, we proposed guiding questions and examples to facilitate the conceptualization of the DP to avoid missing any important details. With the first version of our DPC, we conducted two focus groups for evaluation. One group consisted of 28 data experts from 14 companies and the second group consisted of 8 consultants working with a data service provider. The overall feedback was rather satisfactory as the building blocks and their adaptation to DPs made sense. However, some major modifications were proposed for the next steps such as "*...the title in each section needs to be reframed for better clarity*" (manufacturing company), "*...these questions are very generic so need to make sure they are concrete enough for non-specialists to answer accurately*" (packaging company) and "*...where do I see the version of the data product being designed? It is key in agile approaches*" (data service provider)

The *second design phase* took place between October 2022 – December 2022. We addressed the feedbacks by making the block titles short between 2-4 words, reformulating the questions by breaking it into multiple smaller, more precise questions and adding a header block to capture the name, category and version of the DP being designed. In addition, we colored the different blocks with the goal to offer the participants an intuitive sequence to fill the canvas. We used red for the blocks that inquire about the consumer perspective, yellow for the block around data requirements and green for the blocks that highlight economic viability. Subsequently, we conducted the first round of demonstration of the DPC. Based on the discussions with participants, we selected *Sustainability Report* as an example because most of them were familiar with this DP. Through a third focus group which consisted of 15 data experts from 8 companies, we filled in the empty spaces with sticky notes to capture the relevant aspects of the report for each block. Following up to the demonstration, we received positive feedbacks regarding the ease-of-use and colorfulness of the canvas. Few reflections on this version of the DPC were such as "*...I think we have to mention how this data product would be discovered by the user*" (pharmaceutical company) and "*...the canvas should capture both monetary as well as non-monetary benefits*" (telecommunication company). We incorporated these feedbacks by adding another guiding question about discoverability and modifying an example to mention non-monetary benefits in one of the blocks.

The final *demonstration and evaluation* phase took place in December 2022. It consisted of two in-depth, one-hour long expert evaluations – one represented a global packaging firm and the other a global medical device producer. With minimal support from the research team, the experts filled up and evaluated the canvas by using real-life candidate DPs that their organizations are planning to create. Specifically, the packaging company evaluated the DPC using the 'Account and Hierarchy Data Product' whereas the medical device producer evaluated it using the 'Product 360 Cube'. The feedback received was strongly positive as the experts were satisfied with the final outcome and reflected that the DPC is simple, takes up less time and preparatory work and will interactively challenge the various perspectives that cross-functional teams bring in. Additionally, some other reflections were as "*...this facilitates a standard approach for building a clear mapping of the data to ensure good quality for the data products*" (packaging company), "*...the canvas really helps to be precise in the early stages of the data product development*" (medical device producer), "*...we can make good portfolio decisions whether to promote or not promote a data product*" (medical device producer) and "*...this activity can help us decide concretely the next steps but how to go about the next steps is really the question*" (packaging company).

4 A visual inquiry tool facilitating data product design

4.1 Purpose and overview

The purpose of the DPC is to support cross-functional teams – composed of business users, data and analytics experts, product owners, sponsors – in designing DPs. It goes beyond the strictly technical view on data by encouraging users to perceive it as a product – which implies the focus on end users' information needs and the coordination of critical business resources and activities that play a key role in generating value through this product. Conceptualizing a suitable business model allows companies to offer the most appropriate product that meets consumer demand, while considering the required resources and economic viability [10]. Similarly, articulating the relevant business elements would help companies create a DP that has strong product-market fit and satisfies consumers' information needs. Hence to design the high-level structure of the DPC, we adopt the perspectives used by the BMC [10] as well as innovation and design thinking tools [39]: *desirability* (customer relationships, channels, and customer segments) that gauges the consumers' requirements for the DP which is a vital step in product design approaches [32]; *feasibility* (key partners, key activities, and key resources) that underscores various technical capabilities and tasks to fulfill the consumer requirements as discussed in various DP literatures [3, 21–23][16, 17] and *viability* (cost structures and revenue streams) to understand the economic suitability of investing in the DP akin to similar assessments made during product development [32]. The three perspectives serve as high-level structure to organize the nine building blocks for our DPC (Fig. 1).

4.2   Value proposition

The *value proposition* is located at the center of the DPC canvas for two reasons: First, it outlines the unique aspects of a DP product and the reasons why a consumer would use the DP compared to alternative offerings. Second, the *value proposition* connects the *desirability, feasibility* and *viability* themes and thereby provides a common ground to explicate its relationship with the consumer, technical and economic aspects of a product [40]. This block is instantiated by two questions. As seminal literature [11] argues the need to articulate the users' desire first before embarking on the creation of DPs, the first question aims to inquire about the information needs that the DP is expected to satisfy or existing problems that the DP is meant to solve. Such deliberation facilitates users to formally note down all the information challenges they face and discuss whether a solution already exists. If not, there could be potential in investing into a new DP. To follow up, the second question asks about the concrete value that would be realized if this information need is met. The goal is to encourage users to reflect whether the attained value through the DP is significant enough to merit its creation.

4.3   Desirability perspective

The desirability perspective establishes a combined view about the target consumers and how the DP addresses their needs. Such outlook enables a logical arrangement of the different priorities of the DP consumers and outlines the relevant delivery mechanisms and relationships.

The *consumers* block encourages the outlining of the target consumers, the relevant segments or groups and their types (internal/external). Understanding the consumers' tasks and how the DP supports them is key before DP development [11]. This allows users to gauge the usage scope and highlight relevant stakeholders. Moreover, the distinction between internal and external users has substantial governance implications in terms of access, compliance and security of the DP, as also highlighted in recent literature [35]. The next question goes deeper into inquiring about relevant use-cases for the identified consumers – allowing users to deduce the concrete tasks and the level of details required in the DPs. Eg: a logistics specialist may need minute-to-minute view on outbound drug temperatures, but a senior manager may only need yearly KPIs.

The *delivery mechanism* block looks into the ways in which consumers would like to have the DP packaged and consumed [17]. The first question attempts to grasp the most suitable format in which the DP must be created. This delivery aspect must reflect the consumers' aptitude and ensure that DPs are available in a form and layout that is most convenient for them. Eg: a business analyst may prefer working with datasets whereas a group president may require a single-page dashboard. Subsequently, the next question encourages users to determine the most appropriate interface through which the DP will be accessed. The key idea is to reflect on the appropriate access points that consumers can interact with to attain required insights in the shortest amount of time as well as how secured these access points are, as also discussed in literature [4].

The *consumer relationship* block is meant to reflect on how to maintain relationships with the identified consumers, starting with the discovery of the DP and the collection

of feedback and suggestions for further DP releases/versions. This building block comprises the method through which companies can inform the intended audience about the DP, such as data catalogs [41] or data marketplaces [26]. Quite evidently, the need to discover and address DPs has steadily gained traction in the literature [23]. Similarly, calls to provision high-quality customer support have been made in the product management literature as well [32]. Hence, the next question attempts to highlight the nature of support, technical or non-technical, that consumers expect with regards to the DP – allowing users to determine the type and frequency of assistance that must be guaranteed. For instance, service level agreements between the DP producer and consumers with regards to expected performance, new releases and retirement procedures.
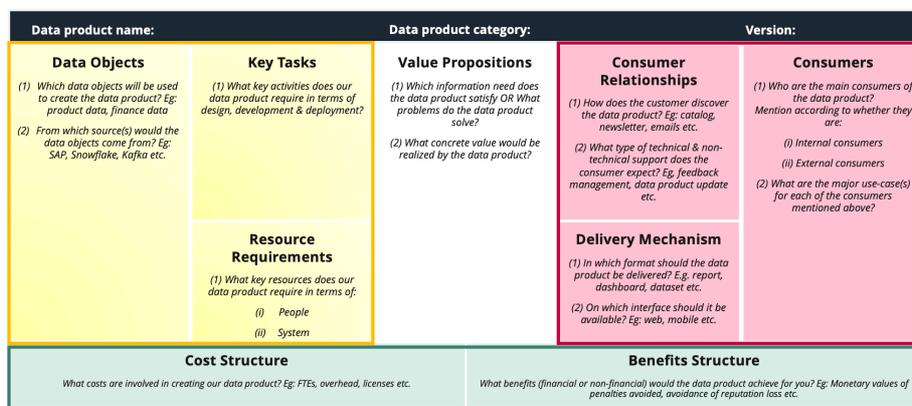

Fig. 1. The Data Product Canvas

4.4 Feasibility perspective

The feasibility perspective captures how the DP is created. It outlines the steps and resources required to convert the identified data needs of the DP into a minimum viable product. Such transformation, in particular, outlines the provisions warranted in terms of data, human and technology.

The *data objects* block looks into the raw materials required to be assembled to build the DP, similar to any physical product. More precisely, the purpose of the first question is to challenge users to identify the exact data required to empower the DP. It builds up on previous reflections around identified problems, type of the consumers and their use-cases. In most situations, the data has to be combined from different functional areas to address complex needs [16] and hence, this activity pushes users to intuitively ponder on the existence and quality of the data. Utilizing as much relevant data as possible allows companies to extract the most value from their data assets [42]. The next question motivates users to consider the various source systems or enterprise platforms present in the organization and whether they hold the required data. In addition, key external sources could be identified and data can be acquired into the organizations [43].

The *key tasks* block aims to explore the concrete actions required to build and deploy the DP. The palette of tasks is not only data-centric but may also include development and testing of the product itself [44]. Similarly, few methods have been discussed to create DPs such as the drivetrain approach [7]. In the DPC, users can deliberate on tasks such as requirement collection, prototyping, testing, performance monitoring and versioning of the DP. Such exercise will ensure all the required set of tasks have been sequentially brainstormed to avoid any misalignment in the DP development process.

The *resource requirement*s block builds up on the task deliberation in the previous step. In order to accomplish the set of jobs identified, users have the opportunity to lay down all the necessary resources presumed to be important. These resources could be both intellectual resources that possess the know-hows for developing and managing the DPs [45] and system resources in terms of tools and platforms for supporting the process. Through this exercise, users would not only be able to determine which resources are needed but equally contemplate on how to access and acquire these often-scarce resources.

4.5   Viability perspective

The viability perspective offers a collective economic assessment with regards to the value that would be generated by producing a DP which effectively addresses consumer-oriented needs. Such appraisal motivates whether an investment into the DP makes business sense.

The *cost structure* block outlines all the related costs that might occur in the course of the DP development and deployment. These might include, for instance, fixed cost to hire consultants, variable costs to administer the data model when needed and other overhead costs – similar to any product development costs [32]. Moreover, maintenance costs are also considered here, for instance, licensing fees or infrastructure cost to host the DP. Conversely, the *benefits structure* block encourages users to articulate on all the tangible and non-tangible positives of the DP creation. Possible benefits are not only limited to tangible financial figures, hours saved or cost reduction but also could be in terms of brand perception and goodwill [46].

4.6   Evaluation and demonstration

To ensure that our artifact is theoretically grounded, we exhibit how the DPC addresses the three design principles outlined by [27] that are pertinent for visual inquiry tools: conceptual model, shared visualization and directions for use. Table 2 provides the summary of this evaluation.

While we conducted demonstrations with practitioners, we only point out here a short summary and the main highlights due to lack of space. The 'Account and Hierarchy Data Product' from the packaging company is meant to provide complete, high-quality information about customer accounts and their parent-child relationship. This DP supports the payments to correct cost centers, thereby reducing operational costs of reinvoicing, risk of fiscal penalties and improving customer relationship owing to less payment errors.

Table 2. Mapping of the DPC to the design principles for visual inquiry tools

Principles	Implementation in the DPC
DP1 Conceptual model	
DP1.1 Frame	The DPC blocks represent the components which teams should inquire into to design DPs. They are mutually exclusive and collectively exhaustive by capturing three central perspectives around a DR: desirability (focused on user), feasibility (focused on technical) and viability (focus on business).
DP1.2 Rigor & relevance	The DPC has been designed following the DSR process outlined by [9]. To ensure practical relevance, over 30 practitioners from 15+ global firms spanning over 8 months were involved in design, demonstration, and evaluation. The DPC is also academically grounded and satisfies the design principles for visual inquiry tools [27].
DP1.3 Parsimony	The DPC has 9 building blocks that are structured into three higher-order perspective components. We also avoid going into prohibitive level of details by outlining a maximum of two most-relevant questions per building block.
DP2 Shared visualization	
DP2.1 Functionality	The DPC exhibits the building blocks as empty problem spaces that allow cross-functional teams to freely represent any facts, ideas, hypotheses, or reflections with regards to DP design.
DP2.2 Arrangement	The value proposition block is placed in the middle as it exhibits relationships with all three perspectives. Next, the desirability aspect on the right is captured to understand consumer needs, followed by feasibility on the left to gauge the technical capabilities to meet those needs and viability in the bottom to foster economic sensemaking.
DP2.3 Facilitation	The DPC perspectives are aesthetically presented using three colors to intuitively guide the sequence in which they should be filled. Most DPC blocks also contain examples to reduce ambiguity for the average participant.
DP3 Directions for use	
DP3.1 Ideation	The DPC is a domain-independent tool that allow cross-functional teams to tap into their knowledge and expertise to exchange creative ideas. Such ideas and reflections can be easily aggregated, rearranged, or removed by using sticky notes which facilitate a flexible collaborative process.
DP3.2 Prototyping	The DPC was demonstrated in workshop settings to exhibit how it functions. Moreover, the canvas also captures the type and version of the DP being worked on, which helps users to revisit and rework on certain blocks depending on the progress of the DP design project.
DP3.3 Presentation	The DPC can be displayed and interacted with in a versatile manner through online (eg: Miro board) or offline settings (eg: printed as poster) for workshop and seminars. Sticky notes can be used to visibly present all the creative ideas and can be easily viewed and critiqued by individuals outside of the teams.

On the other hand, the 'Product 360 Cube' DP from the medical device producer helps employees optimize portfolio management to improve online presence. This DP saves

product data search time by offering consumers a single source of truth by harmonizing fragmented data from multiple sources and ensures data quality. We observe that the first DP has a broader scope with direct implications on external stakeholders whereas the second DP is narrowly focused on certain internal functions as consumers. Such findings indicate towards the varying levels of scope and complexities in DP that are aligned with the larger requirements of the organization [11]. Furthermore, the first DP falls under the master data management domain whereas the latter goes beyond basic master data to integrate transactional data to provide a comprehensive view – underscoring both their needs to provide reusable DPs for broader use instead of being use-case specific. This also explains the aim, as stated during the demonstration, of both firms to deliver their respective DPs in a basic dataset format – to offer the flexibility of repurposing and reusing the data based on the data consumers' highly diverse and specific analytical needs [47] when it is later introduced into the wider organization. Interestingly, we further observe that the findable, accessible, interoperable and reusable (FAIR) principles [41] also manifest while the companies fill up the canvas – the relationships block captures the findable aspect by asking how the DP will be discovered, the delivery mechanism block captures the accessible aspect by understanding where and in which format the DP will be made available. Finally, the feasibility blocks together capture the interoperable and reusable aspect by clearly outlining which data must be integrated from which sources and clearly defining their metadata for future DP creation. During the demonstration and evaluation rounds, we further learnt that the DPs might be developed in several iterations and may require cross-functional teams to revisit the DPC. Additionally, they might have to conceptualize a new version of the DP altogether. Such approach are quite frequent in companies using agile methodologies [48]. Evidently, our canvas is also able to track these changes over time by capturing the name, category and version of the DP being worked on in the canvas header.

5   Conclusion

Leveraging a DSR approach, we propose a DPC as visual inquiry tool that supports cross-functional teams – composed of business users, data and analytics experts, product owners, sponsors – in designing DPs. To the best of our knowledge, this is one of the first tools supporting DP design that goes beyond the purely technical aspects of a DP and embraces relevant business and consumer perspectives. We also apply the established design principles for visual inquiry tools to ensure further academic rigor. To evaluate, we did three focus groups, three demonstrations and two expert evaluations.

The DPC contributes to research as well as practice. For academics, our research conceptualizes DP design by harnessing the desirability, feasibility, and viability aspects of the DP as a mechanism to facilitate data-driven innovations. For practitioners, the canvas provides an interactive yet systematic approach to brainstorm all the vital elements that play an important role in creating DPs.

Although we followed a rigorous DSR approach, we need to acknowledge certain limitations. For instance, our work is limited by the specific research context and the

type of companies we collaborated with. While the BMC offers the economic, operational, and managerial perspectives that match the DPC goals, the BMC and DPC can differ in terms of potential end-users as the former is more strategic in nature whereas the DPC can help design both strategic and operational DPs. In most cases, the experts taking part in our study are also the potential consumers of the DP. Moreover, we aimed for creating a general DP canvas that accommodates the design of any type of DP, implying that the suggested DPC goes beyond other canvases developed for specific analytics products. Hence, future work could center around adapting the DPC for internal or external users. We also see opportunities to study how different canvases and other visual inquiry tools are applied in DP design to help diffuse DP thinking in firms.

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