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An Information Systems Design Theory for Digital Broker Platforms

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Abstract. Service platforms are becoming dominant drivers of daily business operations in a digitalized environment. Research focuses on technological and network effects of such platforms, while socio-technical opportunities remain limited. Guidance support in selecting appropriate digital services on a multisided market platform may help companies with low domain knowledge as it increases their benefits by reducing existing barriers in adopting emerging technologies. We adapt the concept of a broker to a digital platform, which instantiates guidance support on multisided markets as core platform element. Further, we abstract the concept of a digital broker platform as an Information Systems (IS) design theory. By providing the necessary components of an IS design theory, we offer the possibility to derive digital broker platform artifacts, which are theoretically and conceptually grounded. We provide design principles for the method artifact and describe their applicability in an exemplary instantiation of the design theory in the domain of cloud computing. Lastly, we present the artifact's mutability as well as its testable propositions.

Keywords: Digital platform · Information Systems Design Theory · Guidance support · Broker · Cloud computing

1 Introduction

The ongoing digital transformation of organizations and processes leads to opportunities but also to challenges for companies [1]. On the one hand, they need to align their IT and business strategy to keep up with emerging technologies to enter new digital markets and to implement digital services in order to stay competitive. On the other hand, they need to identify the most suited service or application, which is able to represent their respective business model; either by digitally supporting their IT infrastructure or by digitally implementing and offering value propositions [1, 2].

The instantiation of multifaceted digital phenomena leads to an increasing complexity when selecting available digital solutions, challenging consumers with the formulation and knowledge about their own requirements and needs. Likewise, vendors and

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providers of digital applications and services rely on consumers of their products and thus need to provide an adequate description of their products' functionality and features. However due to the lack of a consistent and unified terminology on the demand and supply side, the establishment of an initial contact between digital service provider and consumer remains complex and resource consuming. Even though digital platforms nowadays offer the possibility for both sides to match their potential interests, the selection problem due to missing domain knowledge remains present. However, this issue should not be neglected as especially smaller companies are increasingly forced to deal with emerging technologies like software-as-a-service (SaaS) or infrastructure-as-a-service (IaaS), due to efficiency and data protection issues, as well as the protection of other digital values.

As a solution to this challenging situation, we present a so-called broker platform (BP). It represents a multisided market, which *"bring[s] together (or match[es]) distinct groups, whereas the value for one group increases as the number of participants from the other group increases"* [3]. Such platforms are characterized by a consulting component, enabling users like companies of different classes to distinguish between a variety of provided products and to find the most suited service or application. Thus, on a meta-level, a digital BP can be understood as a solution artifact to the problem class of multisided guidance support. Whereas existing research investigates for instance capabilities for value co-creation and value capture in large platform ecosystems [4], or service network effects on service platforms [5], our research focuses on the causal socio-technical relations of guidance support on digital platforms. Thus, we provide an abstracted description of the development of a multi-sided BP, which can support consumers and providers of digital products in maximizing their benefits by matching both sides' interests.

Our research thereby answers the existing call for research by de Reuver et al. [3] for considering digital platforms from a design science perspective for understanding design practices and making them more dynamic and evolvable over time. Thereby, we extend our previous research focusing on cloud broker platforms [6] by transferring and abstracting the results for the development of digital broker platforms as Information Systems Design Theory (ISDT) according to Gregor and Jones [7]. Thus, it can be understood as a blueprint for future developments of the same artifact type. The remainder of the paper is structured as follows. First, the theoretical background provides an overview of digital BPs and positions our approach in IS theorizing. A conceptual approach of our research is presented in Sect. 3, followed by the description of the components of an ISDT in Sect. 4. The expository instantiation of the ISDT in the domain of cloud computing afterwards can be understood as a first evaluation of the instantiated components and offers an overview of the functionality of a cloud BP. The paper ends with a discussion and summary of the results.

2 Theoretical Background

2.1 Digital Platforms and Brokerage

Digital platforms, and their core concepts, have become subject of research in recent years [3]. They can be defined *technically* as *"software-based external platforms consisting of the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate."* [8] Since platforms are often part of larger ecosystems [9], which merge interests groups with differing needs like consumer, provider, buyer, seller, or developer, there does also exists a *sociotechnical* consideration of platforms, which also considers associated organizational processes and standards [3]. However, due to the very nature of such platforms as multisided markets, differing interests and asymmetric information between participants arise.

Originating from the domain of finance, brokers have emerged to act as an intermediary, aiming at bridging the interests of both market sides. They operate as human or digital consulting agents to initiate and improve the match between suppliers and customers of financial products. Transferred to a broader scope, brokers perform tasks such as aggregating information concerning goods or fostering and reducing search costs (e.g., searching for products, sellers, or buyers), contract costs (e.g., initiating and carrying out the contract), and adaptation costs (e.g., costs incurred in making changes during the life of a contract) for both parties [10]. Due to their versatile applicability, we adapt the concept of a broker and include its functionality into a digital platform. Especially for novice users (e.g., customers with little to no knowledge or expertise within a domain) a digital broker platform can provide guidance to successfully handle existent information asymmetry between consumers and providers of digital services.

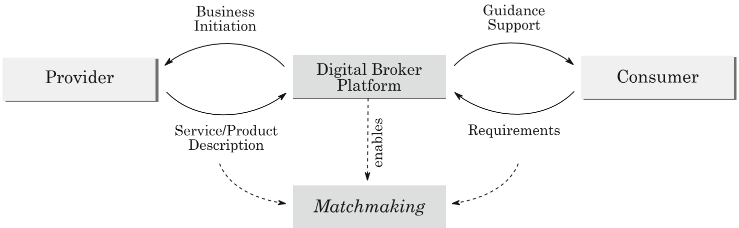

Fig. 1. Conceptual overview of a Digital Broker Platform.

Figure 1 provides an overview of the conceptual functionality of a digital BP. Accordingly, a provider offers a description of their available services or products, which are stored as abstract description within the BP. Likewise, consumers submit their requirements about desired functionalities of digital solutions in abstract descriptions to the BP. By providing an ontology that contains the relevant concepts and represents corresponding constructs within a domain, both the provided and required products are compared and ranked according to their suitability. Thus, a matchmaking of the provider and consumer side is enabled, offering the provider the possibility for a business initiation and to the consumer a solution to the selection problem.

2.2 Design Theory and Theorizing

Design theories (DT) can be regarded as the main artifacts of design science research in the body of knowledge in IS research. Their intention is to explain and prescribe the fundamentals and interdependencies of "the natural world, the social world, and the artificial world of human constructions" [11] as abstracted and generalized phenomena. Thus, when developing a DT, it is necessary for the researcher to explain the ontological positioning towards theory and theorizing. We build our approach on Gregor's [11] conception that a theory "is seen as having an existence separate from the subjective understanding of individual researchers". Following Gregor, we further adopt Habermas' [12] and Popper's [13] three world paradigm. The first (objective) world contains states, processes, and material things typically studied by natural sciences; the second (subjective) world is defined by conscious and unconscious mental states, and the third world consists of man-made entities that objectively exist but are highly abstracted. Accordingly, a DT is assigned to world three as the DT itself exists outside the researcher's mind and belongs to entities like science and theoretical knowledge [11, 13]. The intended goal of our ISDT is a description (method artifact) for the development of a BP by providing relevant components like underlying kernel theories, constructs, and principles of form and function for the BP. Thus, we position our ISDT as *"Theory for Design and Action"* according to Gregor and Jones [7]. Thereby, it aims at enhancing the body of knowledge in IS by providing utility to a group of users, the novelty of the artifact itself, and persuasiveness of claims about its effectiveness [14, 15].

3 Conceptual Approach

The consideration of platform design and development has been subject of research for decades with new platforms constantly being developed in IS and related disciplines [3–5, 16]. Although there exists discussion for an embedding of design science research into the development of digital platforms [3], the consideration of platforms in their function as brokering artifacts is so far missing. Whereas the artifact of a digital platform itself focuses on the instantiation of technological features, a broker platform artifact aims at solving a principal-agent-problem. The desired solution for a consumer (principal) is identifying and choosing the required and best-suited service or application from a software or service provider (agent) on a multisided platform. The process of guidance support is enabled by the concept of a broker, as it provides the abstracted setting of matchmaking and the required infrastructure. Whereas the mere instantiation of a *digital platform* can be regarded as a technical instantiation, the additional component of a *broker* addresses the reduction of information asymmetry that exists between the consumer and provider of digital services. Thus, the artifact of a digital BP combines both, the technical component of IT instantiation and the sociotechnical component of user guidance support and uncertainty reduction. However, since both components rely in their instantiation—and thus usefulness—on each other, their underlying theories and constructs should be regarded from an abstracted perspective. Therefore, we discuss and elaborate the characteristics of a digital BP as *Information Systems Design Theory* according to Gregor and Jones as it *"allows the prescription of guidelines for further artifacts of the same type"* [7]. Thus, we provide the entirety of components relevant for the theoretical and conceptual functionality of a digital BP and thereby offer primarily prescriptive statements about its development process [17].

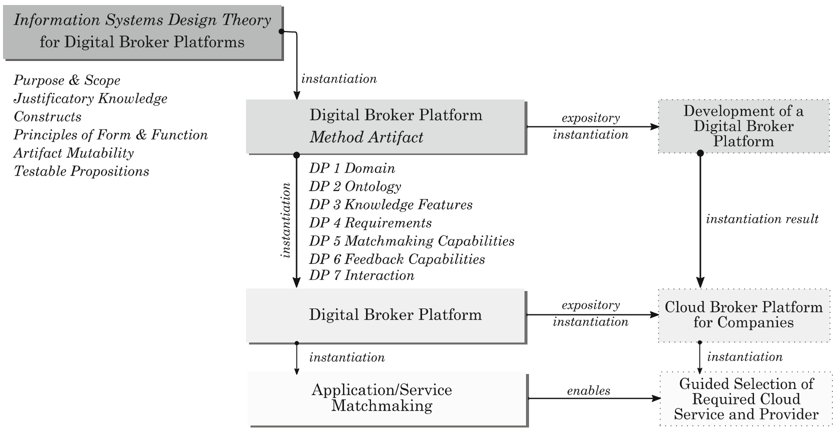

Fig. 2. Conceptual overview of the ISDT for Digital Broker Platforms and its instantiations [17].

Figure 2 offers an overview of our research. The digital BP relies in its instantiation on the BP method artifact which is again an instantiation of the theoretical and conceptual components of the ISDT. Thus, the ISDT combines the necessary components for the BP method and platform artifact and can be regarded as providing a "high level definition of the functioning of an artifact to achieve a design goal and direction toward its construction" [18]. We focus on the construction of such a digital BP by following the derived Design Principles (DPs), enabling us to provide an expository instantiation of the design method, resulting in a digital cloud computing BP.

4 IS Design Theory for Digital Broker Platforms

The anatomy of an ISDT according to [7] consists of eight components out of which six are mandatory: *purpose and scope* (the goal of the Design Theory), *justificatory knowledge* (underlying kernel theories), *constructs* (relevant entities of the theory), *principles of form and function* (the architecture of the artifact), *artifact mutability* (possible changes in the state of the artifact), as well as *testable propositions* (truth statements). Furthermore, we develop an IT broker platform in the domain of cloud computing as *expository instantiation*, thus non-mandatory component of the ISDT.

Purpose and Scope: The goal of the ISDT for digital BPs is to provide a design method for the development of an IT broker platform, which is specifically suited for the guidance of organizations in a multisided market selection process of digital services or applications in a defined domain. We provide design principles [19] and thus offer a methodological description of how to achieve guidance support for a multisided selection problem scenario which is instantiated in a digital platform. However, the ISDT for

BPs does not provide an explanation of the functionality of a service platform as those are depending on the underlying algorithms and technical features. Rather, it describes the methodological conjunction of the concept of guidance (justificatory knowledge) and the conceptual characteristics of a broker platform, thus offering "prescriptions for action in order to reach certain goals" [20].

Justificatory Knowledge: The underlying justificatory knowledge for the ISDT is supposed to "give a basis and explanation for the design" [7] of the artifact. Thus, it can be regarded as a mandatory element for the ISDT as it combines existing guidance and decisional support approaches and thereby provides the digital BP artifact with its functionality and purpose. The development of the digital BP is based on kernel concepts for IS decisional guidance by, for instance, Gregor and Benbasat [21], Silver [22], and extended by an integrated taxonomy of guidance design features in IS by Morana et al. [23]. Thus, the ISDT uses existing relations between guidance support features and synthesizes these dimensions with the required constructs and principles of form and function for an instantiation in the digital BP [6].

Constructs and Principles of Form and Function: The ISDT is characterized by constructs representing necessary components of a digital BP which are used to propose DPs. The entirety of the DPs, with their foundations in the other components of the ISDT can be regarded as digital BP method artifact (see Fig. 2) and the instantiation will lead to an actual digital BP in a pre-defined domain. For their formulation, we followed Chandra et al. [19] and developed action driven and materiality-oriented DPs that prescribe what an artifact should enable users to do and how it should be built in order to do so. Thus, the DPs have a prescriptive character and can be regarded as principles of form and function in the formulation of an ISDT [24]. They were derived from a set of design requirements for guidance systems, which were based on the results of qualitative expert interviews and a systematic literature review [6].

Constructs: Based on the structure of IT service platforms in combination with the underlying knowledge base, we introduce the constructs *domain*, *ontology*, *features, requirements*, *matchmaking capabilities*, *feedback capabilities*, and *interaction* for the ISDT. Due to their strong interconnectedness, the principles of form and function rely in their existence on the constructs, which is why they are represented in the DPs.

Principles of Form and Function: The construct of domain defines the scope for which the intended artifact of the digital BP is valid. In this context it enables the developer of the BP artifact to derive target group and domain specific requirements which will be valid for the pre-defined domain. A domain refers to an abstraction of the business context to which the method artifact is applied and in which the instantiated BP artifact will be valid afterwards.

DP1: Define a *domain* for the BP to distinguish a field of interest for the artifact and to identify target group specific requirements.

Due to the lack of universal definitions and standards for digital services, a unified terminology is needed to make information readable by machines and humans alike.

Therefore, ontologies as popular solutions can be used to leverage information sharing through a system of vocabularies. Making use of a reasonable ontology is a mandatory prerequisite for all further forms of guidance.

DP2: Provide the BP with an *ontology* that allows the detection of commonalties and differences of digital services to create a common understanding.

To identify possible relevant service features that fulfil consumers' requirements, for instance, storytelling in the form of user stories has become a well-accepted practice of agile software development [25]. In the context of a digital broker platform, this can be accomplished by mapping questions posed about predefined use cases from a platform owner (e.g., I need features A and B to perform C).

DP3: Provide the BP with *features* that allow consumers to find relevant digital services with no/low domain-specific knowledge from multiple sources to enhance knowledge for decision-making.

During the selection process, the consumer decides which requirements should be covered by the given digital service and which should not. However, ambiguity and inconsistency can occur when defining requirements due to missing knowledge or a non-specific formulation of needs. In these cases, a functionality must be added that recognizes the actual requirement.

DP4: Provide the BP with features which allow consumers to elaborate and validate the defined *requirements* to enable adequate matching results.

To provide guidance that is not merely informative, the BP should provide a mechanism for providing service recommendations to consumers. Since every manual review of the automatically identified digital service configurations would mean additional effort for the consumer, a recommendation system is important.

DP5: Provide the BP with *matchmaking capabilities* that allow consumers to get recommendations for digital services to limit the effort required for selection and to improve decision-making.

In addition to the informative guidance from the matchmaking service and the suggestive guidance from the recommendation system, the platform should also provide dynamic and participative guidance. This form of guidance is particularly effective for improving decision quality, as well as improving consumers' learning and decision performance [26]. This means that a feedback method is required, as the system should "learn" from former consumers' input.

DP6: Provide the BP with a *feedback capability* that allows consumers to provide/get knowledge from former selection projects to enhance matchmaking capabilities.

Last, a mechanism is needed to validate the provided guidance via third-party actors (e.g., consultants, integrators). The feedback from other consumers provides additional knowledge about the validity of a proposed solution and can help reduce the uncertainty of consumers using digital services and improve decision quality and performance.

DP7: Provide the BP with features that allow for an *interaction* of consumers with other actors (e.g., consultants, integrators) to have access to expertise and obtain participative guidance.

Artifact Mutability: We distinguish between the method artifact for the development of the BP and its mutability as instantiation. Since the described constructs of the ISDT for digital BPs can be transferred to various IT domains, like software-as-a-service (SaaS) or infrastructure-as-a-service (IaaS), the artifact of a digital BP can change its scope of validity depending on the application domain. Furthermore, the technical aspects of the platform's instantiation rely on the researcher or practitioner, who is instantiating the artifact. However, the mere development process of a digital BP, which is characterized by the design principles or the method artifact, refers to basic components of the ISDT itself and thereby needs to remain stable over time.

Testable Propositions: Testable propositions can be regarded as truth statements about the ISDT. Their intention is to demonstrate that the instantiation of the BP method artifact, which follows the principles of form and function, will result in a BP, which can provide a better solution for the digital service selection problem than existing approaches. Thus, propositions like *"Digital Broker Platforms based on the derived DPs are able to better provide guidance support in IT service selection processes than platforms without a brokerage function"* can be tested and evaluated with hypotheses in a real-world setting. This can be done, for instance, by asking the consumer and provider about perceived benefits. Furthermore, it is possible to investigate the service selection in two groups of companies with the same requirements. One group applies the broker platform and is supported by decisional guidance, whereas the other group runs the selection process without guidance support. Thus, if researchers can verify their testable propositions, the DPs are indirectly evaluated as well, since the instantiated artifact was developed by applying them.

5 Expository Instantiation

As instantiation of the ISDT for digital BPs we present the development of a BP in the domain of cloud computing (CC).

Following **DP1,** we chose the domain of CC, as it is an approach to IT sourcing that enables companies to access a shared pool of managed and scalable IT resources (e.g., networks, servers, storage, applications, and services) that are accessible via the internet on a pay-per-use basis without requiring long-term investments [27]. We further refined the validity of our BP for SaaS services. SaaS services have a high number of potential service configurations and the selection of SaaS services is often made by the business departments directly (i.e., without the involvement of the IT department) [28]. This makes decision support for SaaS services highly useful. For the technical implementation, we created a web application consisting of a graphic user interface (GUI) that allows for interaction with and visualization of the platform among the different stakeholders. Thus, our instantiated cloud broker platform (CBP) will be valid for the problem class of SaaS selection in companies, so-called cloud service consumers (CSC). We further derived specific requirements for the platform design as we intended to develop a CBP for guidance support for the class of small companies. **DP2** was instantiated by providing an ontology-based matchmaking component for the platform. It consisted of two elements. First, the decision components, which can be dynamically added and/or removed by the cloud platform owner. Each decision component can contain further sub-components that can be addressed and enriched with information provided by CSPs, who join the platform. In our prototype, we limited the implementation of a technical component, more precisely, a SaaS catalog with features of cloud storage offerings (e.g., encryption, replication, etc.). Second, the matchmaking component, which generates options determined by CSCs' preferences through a pairwise comparison using previously defined weightings of every available cloud service option. To discover and represent the commonalities of the services and to make automated matchmaking possible, we adapted feature models for service design [29] to create a common SaaS profile.

We then applied **DP3** and provided the CSC with a possibility to use a multi-level input on the CBP's front-end, where the CSC can specify requirements, that the cloud service should satisfy. Since complex technologies can be hidden within the services, this specification is provided as questions about the planned use cases, which in turn reduces complexity and simplifies the handling for novice CSCs. As the correct identification of requirements is essential for the later matchmaking, we followed **DP4** by enabling the system to ask the CSC a minimum number of questions, which can be understood as a prerequisite for the matching process. Afterwards, each requirement can be weighted to identify CSC's priority requirements using rating scales. We then used feature models as a representation mechanism for service properties, considering features to be on the right level of abstraction. To gather initial data, we collected publicly available information (e.g., service descriptions, API documentations, user manuals) from cloud storage providers. To ensure the prerequisites for a later automated processing (i.e., for CSPs to provide information directly), we made the catalog available via web services. Subsequently, the matchmaking can be performed by filtering options and presenting those services, which are most suitable in the form of recommendations (**DP5**). We implemented the matchmaking based on a comparison of a requirement vector on the CSCs' side, and a service vector on the CSPs' side. In other words, the consumer's requirements were normalized and represented as a vector. On the provider side, the (satisfied) features are provided as a service vector to enable a comparison of the two vectors. The matchmaking result is a selection of suitable cloud services ordered and displayed according to the degree of fulfilment. **DP6** were instantiated by providing a possibility for CSCs to submit feedback from completed cloud selection projects to improve the matchmaking mechanism. The feedback component is implemented as an AI-based algorithm, learning from successful or non-successful use cases. This information is provided by the CSC who submits their degree of satisfaction with each criterion. Subsequently, the matchmaking can be improved by training the algorithm with the results of successful combinations. Also, qualitative feedback can be submitted via a textual description, allowing the platform owner to modify the matchmaking manually. Finally, the instantiation of **DP7** enables CSCs to engage with third parties such as consultants or integrators to receive expertise. Opening the platform to other parties allows them to offer value-adding services and enables CSCs to receive expertise, build trust, and confidence in potential partners and vendors.

6 Discussion and Conclusion

Our ISDT for digital BP offers the blueprint for a platform artifact which instantiates guidance support by a broker as core element for consumers and providers of digital services and products. Thus, the broker does not only help consumers in their decisional process but also enables providers to be recognized as fulfilling the required needs and provides them with an opportunity for business initiations. Especially novice consumers might feel overwhelmed when it comes to the selection of digital services or products due to missing knowledge in the respective digital domain [6]. Thus, a BP is a suitable tool to reduce uncertainties and help maximize stakeholders' interests. Due to the artifact's mutability, the ISDT offers, on the one hand, stability as it provides with the method artifact and the DPs a clear description and conceptual relations for the development of a digital BP. However, since it can be instantiated in any digital domain and adapted to the contextual requirements, the instantiated BP artifact also provides flexibility, which allows the researcher or practitioner to consider and implement new or emerging components. Therefore, our ISDT can be regarded as a possible answer to the *paradox of change*, which was initially described by Tilson et al. [30] and refers to "*the need for digital platforms to simultaneously remain stable to form a solid foundation for further enrolment, and yet to be sufficiently flexible in order to support seemingly unbounded growth"* [3]. Although the authors initially described this phenomenon in the context of digital infrastructures, we provide, with the described anatomy of the ISDT, the necessary components of stability and change for an adaptation into the context of digital platforms. Existing digital platform research often focuses on the technological instantiation and incorporation of software and thereby focuses on reduced deployment times, minimized long term overheads, as well as reduced upfront implementation [5]. Thus, our approach adds to existing research in the domain of digital platforms by focusing on the principal-agent relationship between the consumer and provider of digital services or products, and which is reduced by the instantiation of guidance support by a broker. Even though information asymmetry relationships were previously investigated in a platform context, they rather focused on the stakeholder groups of platform providers and software or app developers [31, 32] than consumers of such services.

Our research approach provides several contributions to the body of knowledge in IS. First, we provide the conceptual model of a digital BP, which represents a matchmaking platform and offers a solution to the problem of information asymmetry between consumers and providers on digital platforms. Thereby, we offer a stronger sociotechnical perspective on the concept of digital platforms, which will, in its instantiation, be especially helpful for smaller or novice companies that do not have the financial or personnel resources for professional consulting. Second, we abstract this concept of guidance support from a design science research perspective and develop an ISDT for digital BP, which answers the call for research by de Reuver et al. [3]. The formulation of DPs for the conjunction of the consumers and providers digital market side is so far missing in the body of knowledge in IS research.

Thus, as practical contribution of our research, the derived components of the ISDT provide researchers and practitioners the possibility to build guidance support BP artifacts of the same type but in different domains. Thereby, the artifact of a digital BP offers an improvement in the selection process of digital services and products for companies of different sizes and sectors as well as for the respective providers.

Like every research project, our approach has limitations. The description of the ISDT components is highly theoretical, which is why our presented development approach lacks practical depth. However, this is explained by the high level of abstraction in theory components, which is needed for the formulation of a method artifact, and which can be applied in various domains. Furthermore, even though the developed DPs are based on an extensive literature review in the field of decisional guidance support, the complex domain of digital transformation requires an ongoing adaption to new and emerging phenomena. Thus, the knowledge base for the ISDT can be considered as constantly evolving and should therefore be subject to ongoing research in IS.

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