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(Review Article)

Platform Engineering and Developer Experience: A Systematic Review of Concepts, Benefits and Future Directions

Harshad Pitkar [*]

Cummins Inc.

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Abstract

Platform engineering has been recognized as an important area of focus to deal with the increasing complexity of software development environments. By creating Internal Developer Platforms (IDPs) that hide infrastructure complexity and enable self-service, organizations seek to improve developer experience (DevEx) and speed up software delivery. This paper reports a systematic review of the literature on platform engineering, covering its fundamental concepts, connection to developer experience, benefits, challenges of implementation, and future research. Based on recent literature and industry trends, we identify that platform engineering is highly effective in reducing cognitive overload, improving developer productivity, and achieving faster delivery cycles if implemented with a product mindset. Success factors include considering platforms as products, offering golden paths and developer portals, measuring DevEx with a mixed-methods approach, and achieving standardization with flexibility. But organizations are confronted with severe challenges in identifying suitable levels of abstraction, overcoming organizational barriers, and sustaining platform capabilities. Future trends indicate promising areas in observability-centric platforms, AI-infused IDPs, and formal reference models. This systematic review aims to provide a comprehensive understanding of the role of platform engineering in influencing developer experience for researchers and practitioners.

Keywords: Platform Engineering; Internal Developer Platforms; Developer Experience; DevOps; Self-Service Infrastructure; Cognitive Load; Cloud Computing; Security Automation

1. Introduction

The contemporary software development landscape is characterized by unprecedented complexity. Organizations increasingly adopt cloud-native architectures, microservices, and distributed systems, requiring developers to navigate intricate infrastructure concerns alongside core business logic [1], [2]. This complexity imposes substantial cognitive burden on development teams, diverting attention from value-creating activities and hindering productivity [3]. Traditional DevOps practices, while valuable, have proven insufficient for managing this complexity at scale, particularly in enterprises with diverse applications across multiple environments [9].

Platform engineering has emerged as a strategic response to these challenges. By designing and operating internal platforms that abstract infrastructure and operational complexity, organizations aim to provide development teams with standardized, self-service capabilities that accelerate delivery while reducing cognitive load [4]. These Internal Developer Platforms (IDPs) represent a paradigm shift from infrastructure-as-code to platform-as-product, treating internal development capabilities as curated products with defined user experiences, service levels, and continuous improvement cycles [3].

[*] Corresponding author: Harshad Pitkar

The relationship between platform engineering and developer experience (DevEx) is fundamental. Developer experience encompasses the lived experience of developers and the friction points they encounter in their daily work [30]. Poor developer experience manifests in reduced productivity, lower job satisfaction, decreased product quality, and higher employee turnover [30]. Platform engineering directly targets these friction points by providing predictable, discoverable workflows and removing incidental operational work [5].

Despite growing industry adoption and enthusiasm, platform engineering remains an evolving discipline with limited empirical research and inconsistent terminology [25]. Organizations struggle with fundamental questions about platform scope, governance models, measurement approaches, and organizational structures [9]. This paper addresses these gaps by systematically reviewing the current state of platform engineering literature, synthesizing key concepts, benefits, challenges, and future directions.

The remainder of this paper is organized as follows. Section 2 establishes the conceptual foundations of platform engineering and IDPs. Section 3 examines the relationship between platform engineering and developer experience. Section 4 analyzes reported benefits and capabilities. Section 5 explores the platform-as-product mindset and associated practices. Section 6 identifies implementation challenges. Section 7 discusses measurement approaches. Section 8 outlines future directions and emerging trends. Section 9 concludes with implications for research and practice.

2. Conceptual Foundations of Platform Engineering

Platform engineering is described as the "practice of designing and operating internal platforms that abstract infrastructure and operational complexity from product teams" [1], [25]. Unlike traditional infrastructure management, platform engineering focuses on self-service capabilities, standardized building blocks, and developer-centric interfaces [4]. The field leverages the principles of DevOps and addresses the limitations that occur when the principles are scaled to the enterprise level [9], [27].

2.1. Internal Developer Platforms

Internal Developer Platforms (IDPs) are the primary artifact produced from platform engineering activities. IDPs are reusable components such as provisioning, continuous integration and delivery, and security, which are made accessible to product teams through self-service interfaces. The platforms provide abstraction layers over the complexities of the operation, enabling developers to focus on business logic rather than infrastructure concerns [8].

The architecture of IDPs includes several primary components. Provisioning and Infrastructure-as-Code (IaC) modules provide reusable building blocks for infrastructure resources, enabling developers to access the components through the platform. CI/CD and GitOps pipelines are integrated with the platform to provide automated delivery capabilities. Developer portals and golden paths are the primary interface layer, providing discovery and invocation capabilities for the platform and its services [10]. Observability and policy controls provide security and operation guardrails across the platform [11].

2.2. Reference Frameworks and Models

To overcome this gap of understanding within the field, Kamp et al. proposed a reference framework for platform engineering. Kamp et al. proposed the Platform Engineering Reference Model (PE-RM), which is based on the Reference Model for Open Distributed Processing (RM-ODP) framework, to provide a common vocabulary and a structured approach to design platform engineering strategies [25]. The multi-view framework helps organizations to better align design and implementation decisions while communicating effectively with other stakeholders [23].

Bayer explored further how metamodeling concepts can be used to improve IDPs and cloud platforms to support business agility [17]. Metamodeling approaches provide organizations with a way to manage complexity within a multi-cloud environment while allowing for flexibility.

2.3. Organizational Elements

Platform engineering introduces specific organizational structures, most notably platform teams that operate the platform as a product. These teams curate modules, templates, and expert support for consumer teams, functioning as internal service providers with defined responsibilities for platform reliability, evolution, and user support. The platform team model represents a departure from traditional centralized operations or fully decentralized DevOps structures, seeking to balance autonomy with standardization.

3. Platform Engineering and Developer Experience

Platform engineering identifies particular types of organizational design, most notably the platform teams that own the platform as a product. The teams own modules, templates, and expert support for consumer teams. They act as internal service providers with particular obligations around the platform, including support and evolution. The platform teams are seen as an innovation over the traditional centralized operating model and the fully decentralized DevOps model.

Platform engineering directly addresses DevEx by reducing frictions and providing predictable and easily discoverable workflows [30]. The connection between platform engineering and DevEx is mediated by several paths, which cumulatively reduce cognitive load and improve developer satisfaction and productivity.

3.1. Cognitive Load Reduction

Cognitive load, or the mental effort required to carry out development tasks, is considered one of the primary areas targeted by platform engineering efforts, as defined in [6]. By offering preconfigured templates that abstract away from less valuable infrastructure concerns, platforms help development teams maintain their attention on product logic rather than infrastructure concerns, as described in [3] and [6]. Tsyganok's research shows that, in particular, integrating customer-centricity and UX design principles into internal platforms can help mitigate cognitive load, thus improving key dimensions of DevEx, including satisfaction, flow, and efficiency, as described in [3].

Empirical research validates these assumptions. In their research, Soeldner et al. showed that developers working with a well-designed platform could dedicate 75% less time to operations compared to pre-platform baselines [8]. This reduction in operations-related attention allows developers to redirect their cognitive efforts to more valuable tasks, including feature development, architectural design, and problem-solving.

3.2. Flow and Developer Satisfaction

The state of developer flow, the ability of the developer to be engaged in the activity of development without interruptions or context switches relies on the ability of the platform to minimize interruptions and context switches [30]. This is achieved through the provision of optimal paths and current templates that are supported by expert guidance [10]. The ability of the platform to allow the developer to quickly provision environments, deploy applications, and access observability data using consistent interfaces also reduces the number of interruptions or context switches, thus maintaining the state of developer flow.

The second important aspect of DevEx is developer satisfaction. This is also positively influenced by the ability of the platform to mitigate the level of frustration that arises from the complexity of the infrastructure. The ability of the platform to support self-service allows the developer to perform tasks without waiting for support from the operations team [2], [5]. However, the satisfaction of the developer is also dependent on the quality of the platform because a poor platform can actually negatively influence the DevEx [9].

3.3. Feedback Loops and Continuous Improvement

Observability, as well as unified monitoring integrated within platforms, create a feedback loop that provides insights for platform improvements, as well as highlights areas of pain for the developer, which can be addressed. Rachael emphasized that with the application of platform engineering, which focuses on observability, the overall developer experience is greatly enhanced, as it provides a consolidated approach to monitoring, which can be used to identify areas of pain for the developer [11].

4. Benefits and Capabilities of Internal Developer Platforms

Platform engineering provides a number of measurable benefits, which can be observed from different perspectives, such as development velocity, efficiency, as well as system reliability (2, 12). Although the exact benefits vary, a common pattern can be observed from the literature.

4.1. Developer Productivity Gains

Enhanced productivity for the developer is the most common benefit that can be observed from the application of platform engineering. The application of a platform can greatly improve productivity, as it removes unnecessary infrastructure work, thus providing a ready-to-use component that can be used to accelerate common workflows [12]. According to Kalluru, IDPs can greatly improve software delivery velocity, as well as system reliability, while optimizing the developer experience for organizations. Similarly, another research conducted by Meghani observed that platform standardization, as well as the automation of compliance, can lead to a 65% improvement in the overall developer experience, as well as a 47% improvement in performance within regulated enterprises [18].

This enhanced productivity can be observed from different perspectives, such as a reduction in time-to-market for new services, faster iteration, as well as a reduction in time spent on operations. This can also be observed from a different perspective, as the application of a platform, which encapsulates complexity within a standardized module with documentation, can reduce the learning curve for new team members, as well as reduce the expertise needed for the development of production-ready services [6].

4.2. Self-Service Capabilities

The self-service features allow the development teams to provision resources and services, deploy applications, and use platform services without the intervention of the operations team. This reduces the dependency and limitations that have often hindered software delivery. Developer portals and APIs define the interface for self-service, which provides a list of services that are available for use [10].

There should be a balance to ensure that the platform provides enough flexibility to support various use cases while at the same time providing guardrails to ensure security, compliance, and operational standards [2]. Golden paths define the workflow for common use cases to ensure that the developers navigate the balance of flexibility and guardrails by providing easy paths for common use cases while at the same time allowing for exceptions [10].

4.3. Standardization and Consistency

Platform engineering promotes standardization among different development teams, which in turn reduces fragmentation and increases maintainability of the system [8]. Using standardized infrastructure, deployment, and observability tools promotes standardization throughout the organization. This standardization process makes it easier to debug the system, increases the ease of knowledge transfer, and reduces the mental overhead of switching between different systems [6].

However, standardization too much of the system might lead to lack of innovation and frustration among teams requiring different features and functionalities. A good platform engineering approach will ensure a good balance of standardization and team-specific features and functionalities.

4.4. Operational Efficiency and Reliability

Apart from the benefits of platform engineering to the developers, it has many benefits in relation to the operation of the system and its reliability [12]. A centralized platform team will be able to invest in robust and reliable infrastructure tools, which the development teams might not be able to afford.

Ekanayaka et al. showed the benefits of platform engineering in the implementation of the integrated DevOps infrastructure, known as Kubeflow, simplifies the deployment of microservices through the use of automation, containerization, and orchestration tools [29]. This enables the developers to focus on the development of applications while ensuring the efficiency of the deployment process rather than worrying about underlying infrastructure.

5. Platform as Product: Practices and Principles

Considering platforms as products instead of infrastructure projects is an essential mind-set change with considerable implications for platform success. The platform-as-product model uses product management disciplines, user experience (UX) design, and incremental delivery to build internal platforms with their development teams as the target customer-base [6].

5.1. Customer-Centricity and User Experience

Being customer-centric requires platform teams to build an in-depth understanding of the needs of their target customer-base through interviews and analytics-driven roadmaps [6]. According to Tsyganok, the consistent application of customer-centricity and user experience design to internal platform users as developers leads to reduced cognitive load and improved attributes of the developer experience (DevEx). The customer-centricity of the platform-as-product model is different from the conventional infrastructure project focus on technology requirements instead of user experience [6].

Developer portals are an important aspect of user experience in platform engineering and are an essential part of the platform-as-product model with considerable implications for platform adoption and use by the target customer-base [10]. The quality of the portal is essential to provide an improved user experience with features such as searchability, well-defined navigation paths, and up-to-date templates to reduce adoption costs and increase discoverability of the platform by the target customer-base. Poor portal quality will negatively affect platform adoption irrespective of its technology capabilities.

5.2. Service-Level Thinking and Support

Platform-as-product considerations also apply to service level agreements and support models with regard to platform consumers as developers [25]. The definition of service level agreements ensures that there are clear understandings regarding platform reliability and performance with the provision of expert support being an essential feature of an exceptional user experience with considerable implications for platform adoption by the target customer-base through improved support response times to address queries and issues of the target customer-base through well-defined support flows and playbooks.

6. Implementation Challenges and Barriers

Despite these established advantages, there are many challenges faced by an organization in implementing and sustaining platform engineering initiatives.

6.1. Abstraction and Flexibility Tensions

The determination of abstraction level is a major technical challenge in platform engineering. Abstraction levels in platform engineering must be high enough to allow developers to be free from constraints but also low enough to avoid a lack of simplicity in code. As noted by Soeldner et al., standardization of infrastructure code is a major challenge in platform engineering, particularly in a decentralized environment [8].

Another major challenge in platform engineering is organizational resistance to change. Organizations with fully autonomous development teams might view platform engineering as a constraint to their freedom. On the other hand, there might be a lack of understanding in teams that lack DevOps skills to fully benefit from a self-service platform [9]. Veldurthi noted organizational resistance to change as a major challenge in platform engineering, requiring expert support to overcome this challenge [9].

6.2. Organizational Adoption and Resistance

The cultural side of platform engineering is also a major challenge in this field. Organizations with a high degree of departmentalization might have a hard time dealing with the cross-functional nature required in platform engineering. The platform engineering team must deal with a number of stakeholders, including multiple development teams, to ensure a cohesive platform engineering strategy [6].

6.3. Skills and Maintenance Costs

Platform engineering requires specific skills in infrastructure, software development, product management, and user experience design [8]. The development and maintenance of such a diverse set of skills within a team pose a challenge to many organizations [8]. As identified by Soeldner et al., a platform team needs to ensure standardized and security-enhanced modules to the entire organization. Another challenge in platform engineering is the cost of maintenance. Platforms need to be constantly updated to ensure the integration of emerging technologies, security fixes, and changing needs from developers.

6.4. Technology Complexity and Evolution

The high rate of change in technologies used in a cloud-native ecosystem makes it difficult to ensure platform engineering. The integration of diverse technologies such as container orchestration, service meshes, observability, and security is a challenge in ensuring a platform engineering environment [29]. As identified by Aslina et al., modern software development environments, such as with the adoption of Kubernetes, have a high learning curve and infrastructure management challenges [16]. Many traditional IDPs lack an intuitive interface to meet diverse user needs, from novice developers to engineering leaders.

7. Measurement and Metrics

Measuring platform success and developer experience requires combining subjective developer feedback with objective engineering telemetry [4]. Organizations should choose signals that take into account developer outcomes and platform adoption and instead avoid metrics that encourage non-productive behavior. [30].

7.1. Developer Feedback and Satisfaction

Surveys that obtain developers' feedback can offer first-hand information about developers' satisfaction, flow, and experiences with the platform. Noda et al. state that developer experience involves developers' day-to-day experiences and the bottlenecks they face during their workflow [30]. A survey can measure ease of use, documentation, promptness of support, and developers' satisfaction with platform functionalities.

However, it can only offer limited insights as developers may be unaware of alternative approaches or may have adapted to existing friction. Combining it with interviews and observational studies can offer more insights about developers' needs and pain points.

7.2. Adoption and Usage Metrics

There exists a strong correlation between platform adoption metrics and developers' interest in platform capabilities [25]. The level of adoption of platform capabilities, such as templates, portal activity, and services, indicates platform adoption.

Conversely, it may also indicate poor adoption as developers may find it difficult to use the platform or may be dissatisfied with platform capabilities.

Moreover, it can also help identify which capabilities are most important to developers and which capabilities are less important or unused.

8. Future Directions and Emerging Trends

Formal reference models and metamodeling techniques have the potential to enhance the interoperability and agility of the platforms in multi-cloud scenarios [17]. Kamp et al. proposed the reference model of platform engineering. This reference model enables organizations to develop their own strategies for platform engineering by providing a structured framework [25]. Formal reference models can accelerate the adoption of platforms by providing a common language and implementation roadmaps. Bayer's work on the concept of metamodeling can be seen as an example of the potential of these abstractions to improve IDPs and cloud platforms to support business agility.

As the field of platform engineering progresses, new career paths are emerging. Organizations should realize the difference and importance of the role of the platform engineer. They should differentiate it from the role of a DevOps engineer or an infrastructure engineer. This has resulted in the emergence of a new career path that demands a unique set of skills to be effective in the role of a platform engineer [9].

Low-code support has the potential to extend the reach of the platforms to more developers with varied skill sets to utilize the potential of the platforms effectively [9].

9. Conclusion

Platform engineering has been recognized as a significant area of expertise for dealing with the complexity that arises in software development. The use of Internal Developer Platforms (IDPs), which remove the complexity of infrastructure, can significantly improve the experience of the developers while accelerating the software delivery process. The present review aims to synthesize the existing knowledge in the area of platform engineering, including its concepts, association with the experience of the developers, advantages, difficulties, and potential future prospects.

Some of the important findings of the present review are as follows:

- **Conceptual understanding:** Platform engineering can be defined as a term that encompasses the concepts of self-service, standardized building blocks, and the experience of the developers. The components of the internal developer platforms include provisioning, CI/CD, portals, and observability. The reference models, such as the

Platform Engineering Reference Model, can be used to design the platforms. The reference models can be used to implement the platforms.

- **Experience of the developers:** The experience of the developers can be significantly enhanced by the use of platform engineering. The use of platform engineering can significantly improve the experience of the developers by reducing the cognitive load, improving the experience of the developers in terms of flow, and improving the satisfaction of the developers. The use of internal developer platforms can significantly reduce the operational focus of the developers, as indicated by the empirical studies, by as much as 75%. The experience of the developers can be enhanced by the use of preconfigured templates, the use of golden paths, and the use of expertise.
- **Measurable benefits:** Organizations report substantial productivity improvements, faster time-to-market, and system dependability as benefits of their platform engineering initiatives. Quantified studies demonstrate the effectiveness of DevEx improvements of 65% and performance improvements of 47% in regulated organizations [18]. Self-service, standardization, and system efficiencies all contribute to these benefits.
- **Product mindset:** Viewing platforms as a product rather than an infrastructure project has a major impact on the success of the overall platform engineering effort. Customer-centric approaches, user experience design, phased rollout, and continuous integration of feedback all contribute to the overall effectiveness of the platform engineering effort. Service-level approaches and governance ensure the platforms meet the varied needs of developers while maintaining organizational standards.
- **Implementation challenges:** Organizations face significant challenges to the adoption of platform engineering. Balancing abstraction with flexibility, overcoming organizational resistance to change, skills shortages, and technological complexity all pose significant barriers to the adoption of platform engineering. Determining appropriate levels of abstraction, overcoming the organizational and cultural challenges of adopting platform engineering, and ensuring the ongoing viability of the platforms in the face of technological evolution require sustained commitment to the overall effort.
- **Measurement approaches:** Effective measurements of the benefits of the overall effort require the integration of subjective feedback from developers with objective measurements of the overall engineering effort. Surveys and system data provide complementary approaches to the overall effort and can be used to improve the overall effectiveness of the platforms while meeting the varied needs of developers. Observability-driven methodologies provide the framework to ensure continuous improvement of the overall developer experience.
- **Future directions:** Emerging trends in the field of platform engineering include the use of observability-driven platforms, AI-augmented IDPs, reference models, and the use of specialized career paths. These emerging trends likely portend increased accessibility of the overall effort and the potential to create more interoperable and more automated platforms.

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