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**Preprint**

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*Suggested Citation:* Giessmann, Andrea; Feurer, Sven; Schneider, Thomas; Wenzel, Stefan (2015) : Consumers' Preferences on Platform as a Service and SAP's Engineering Response, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft, Kiel und Hamburg

This Version is available at:

<https://hdl.handle.net/10419/106129>

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# Consumers' Preferences on Platform as a Service and SAP's Engineering Response

by Andrea Giessmann, Sven Feurer, Thomas Schneider, and Stefan Wenzel.



# Consumers' Preferences on Platform as a Service and SAP's Engineering Response

Platform as a service (PaaS) solutions are changing the way how software is produced, distributed, consumed, and priced. To be competitive on the market, PaaS providers have to be aware of drivers of successful platforms and design or adjust solutions accordingly. Surprisingly, prior research has made little attempt to investigate consumers' preferences on PaaS that influence developers' choice on PaaS solutions. This paper examines this understudied issue through a conjoint study. Based on the results, SAP's engineering response is present in terms of SAP's OnDemand Platform, SAP's Business ByDesign Studio, SAP HANA Cloud solution as well as SAP's Store.



## 1. INTRODUCTION

Platform as a service (PaaS) solutions are changing the way that software is produced, distributed, consumed and priced. PaaS provides an execution environment where external developers deploy and run their components. PaaS solutions facilitate the development, testing, and management of software components as well as the exchange of knowledge between developers [1].

According to [2], Platform as a Service is currently at the peak of inflated expectations. The market for PaaS is growing fast and will have a potential market volume of more than €6 billion in 2014 [3]. Currently, the market is largely fragmented. However, market research companies expect that the distribution of market shares will change dramatically in the next few years [3–5]. Providers of PaaS are under pressure to further develop their products, in order to sustain on the market and meet the different customers' needs.

The research presented in this paper focuses on the design of PaaS by conducting an empirical investigation on their essential features from the perspective of third-party developers. Thus, the research question can be formulated as follows: What are the preferences of third-party developers on PaaS? To find out what determines the choice of a PaaS, an adaptive choice-based conjoint analysis was conducted, which is described in the following. After presenting the results of this study, SAP's engineering response is presented. Finally, the last section closes the paper with a

brief summary and an outlook to further research.

## 2. STUDY DESIGN

### 2.1 Attributes and Levels

The first step in designing a conjoint study is to identify the attributes that are relevant to consumers in forming their preferences. Initially, a list of literature containing about 30 contributions which seem to be relevant to this study resulted from a systemic literature review [6], [7]. Using these articles and papers, a first list of attributes and attribute levels was developed and served as the starting point for a focus group discussion. The initial list contained nineteen attributes with a total of 55 attribute levels. After the focus group discussion as well as expert interviews, the list was further extended to 21 attributes. However, five attributes have been considered as knock-out criteria for PaaS:

- Availability of at Least 99%
- Fully Automated Scalability
- Standardized APIs
- High Security Standards and Access Controls
- Backup and Disaster Recovery

These attributes have to be necessarily implemented into PaaS solutions in order to succeed on the market in the long-run. Due to their importance, these features have to be guaranteed in all PaaS solutions. Therefore they are considered as mandatory and haven't been evaluated within the survey. The remaining attributes were prioritized, and the top ten attributes were included in the design of the questionnaire. The

final list which serves as the foundation for the conjoint survey contains ten attributes with altogether 26 corresponding levels and is presented in Table 1 below.

### 2.2 Questionnaire design

The online questionnaire was divided into five main sections: The first section, after a brief introduction, contained the so called Build Your Own (BYO) questions. It asks respondents to indicate their preferred level of some of the attributes. Based on the answers, the subsequent choice questions will only contain PaaS concepts including attribute levels that are relatively concentrated around the respondent's preferred levels [8].

Second, the screening section asked respondents whether they would consider specific PaaS concepts shown a possibility or not. While the participants are answering, the software scans their decisions in order to recognize non-compensatory behavior [9]. In case the application of such a screening rule can be assumed after the first three screening tasks – meaning that the respondent has systematically avoided an attribute level – the program asks the question of whether that level would be completely unacceptable. Attribute levels that have been identified as unacceptable will not be displayed again during the rest of the survey (cut-off rules). This extends to attribute levels that are systematically selected.

The choice tournament was the central component of the survey. Based on their answers to previous questions “[...] respondents are evaluating



concepts that are close to their BYO-specified product, that they consider 'possibilities', and that strictly conform to any cut-off (must have/unacceptable) rules" [8]. Because the participants have already indicated which attributes are most important to them by establishing cut-off rules, the exact number of stimulus sets shown depends on the concepts marked as possibilities during the screening section.

The last section of the questionnaire serves for calibration. By reshowing six concepts, including the concept identified in the BYO section as well as the one winning the choice task tournament and four others. For each concept, the participant is asked how likely he/she is to buy it, if it were available in the market, using a five-point scale from "Definitely would not" to "Definitely would" [8].

### 3. RESULTS

In order to obtain qualified results the study addressed potential participants, whose employers were already using PaaS or at least planned to invest in using one. A total of 266 people participated in the survey and completed 103 data sets. The remaining respondents either did not finish the questionnaire (151) or were disqualified because they did not pass the capability assessment (12). The findings presented here are all based on the completed data sets.

#### 3.1 Participant's background

Almost 62 % of the respondents worked for a company in the software sector, a little more than 4 % in the manufacturing industry, more than 11 % in

Attribute	Description
<b>Development Environment</b>	In order to enable external developers to use cloud platform, they can provide a development environment. Development environment can be either online, meaning a completely browser-based development environment is offered online, or offline by providing a SDK.
<b>Test Environment</b>	A test environment facilitate debugging, testing and simulation of developed components. A test environment can be either provided or not.
<b>Monitoring</b>	Monitoring of usage and load of the processes running on the platform. It can be predefined and just provide a fixed set of views, or customizable and let the user specify dynamic notifications, thresholds, etc.
<b>Mobile Access via App</b>	Cloud platforms can provide a mobile user interface to access the whole development, management and monitoring functionality; it can be limited to monitoring only, or not provided at all.
<b>Community Features</b>	The PaaS provider offers either a business-related social network for the users and developers of software on the platform, or a knowledge sharing platform, or no community features at all.
<b>Market Penetration</b>	The market share of a PaaS provider can be high or low.
<b>Pricing</b>	The pricing model can be revenue sharing, where the PaaS users pay a part of the revenue they make with their software to the PaaS provider, or, more commonly, fixed recurring fees (flat rate) or a pay per use model.
<b>Marketplace Functionalities</b>	The PaaS provider maintains a marketplace where customers can buy software components. The marketplace can offer the provisioning of the requests software, and in addition to that also offer linkage to other popular marketplaces.
<b>Payment Handling by Marketplace</b>	For the marketplace, the PaaS provider could provide the payment infrastructure, or merely usage information.
<b>Migration among PaaS Providers</b>	If users decide to migrate their applications to another platform, the PaaS provider can either offer Migration as a Service, or provide import/export tools, or none of these.

Table 1: Conjoint Attributes

service companies, around 2 % in governmental institutions, and 21 % in other businesses. The vast majority (82.61 %) of the respondents were working for large enterprises with more than 250 employees, 13.04 % for small companies with less than 50 employees and 4.35 % for medium-sized enterprises with 50-250 employees. Most of the participants considered themselves as employees (77 %) and the rest (23 %) as members of the management.

The ages of all the respondents were between 23 and 63, with a mean of approximately 34 and a median of 31. Almost 59 % of the

participants were technically oriented. Not surprisingly, 76 % of all the respondents answered the question on how they would rate their technical skills on a scale from 1 (beginner) to 7 (expert) with a value of 5 or higher. However, only 28 % ranked themselves with a value of 5 or higher when it came to experience with PaaS.

Of the evaluated companies, 53.04 % already used a PaaS solution and 25.22 % planned to invest in such an on-demand solution. The remaining 21.74 % of the respondents did not know whether their employer was using or planning to invest in

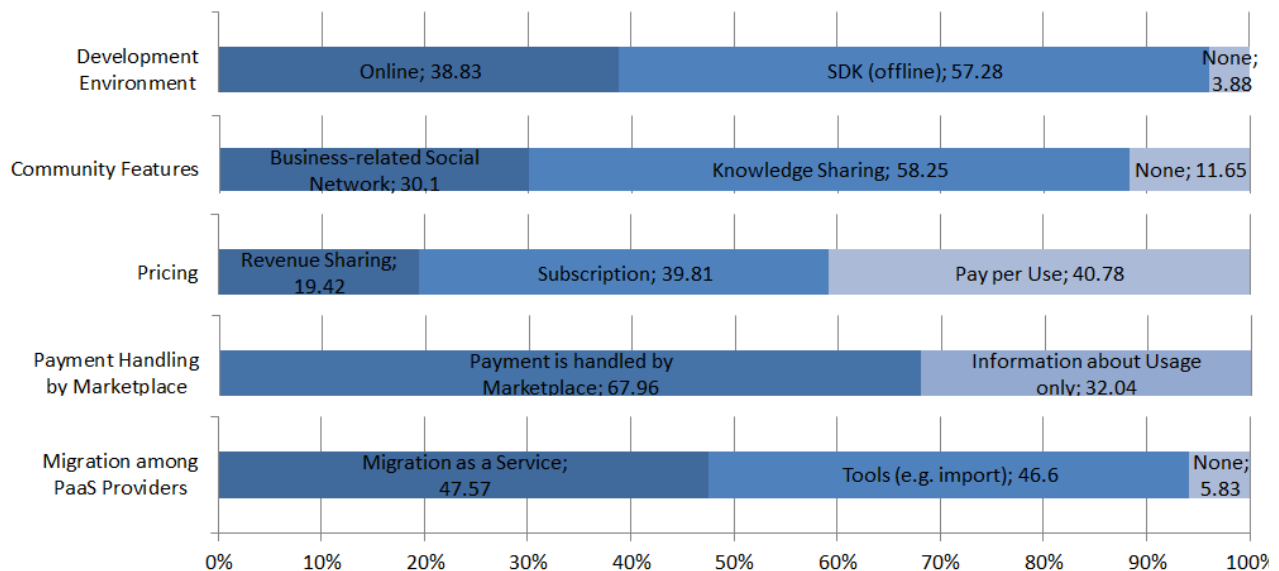


Figure 1: Frequency distribution in 'build your own' section

PaaS. Of the participants, who knew that the company they were working for was using a PaaS solution or at least planned to invest in one, 31.15 % declared that the platform would be used to deploy applications for internal purposes only, 13.11 % claimed to work for firms selling or planning to sell the applications, and the remaining 55.74 % stated that they develop or plan to develop applications for both internal and external purposes.

### 3.2 Build Your Own

The respondents' answers to the build your own section, where they had to indicate their preferred attribute levels in terms of the development environment, community features, pricing, payment handling by marketplace, and migration among PaaS providers, are displayed in Figure 1. Of the respondents, 57.28 % stated that they would prefer an offline development environment, while 38.83 % preferred an online one. Less than 4 % indicated that they are not interested in a development environment.

The majority of the participants preferred knowledge-sharing tools as a community feature and around 30 % stated that they would like to have a business-related social network as part of a cloud platform. A total of 11.65 % of the respondents were not interested in community features at all.

With 40.78 % of the answers, pay-per-use was the most frequently named preferred pricing model, followed by 39.81 % for subscriptions and 19.42 % mentioned revenue sharing as their preferred pricing model. More than two-thirds (67.96 %) of the participants stated that they would prefer if the marketplace could handle payments and 32.04 % would prefer to just get usage information from the marketplace.

Only 5.83 % indicated that they were not interested in migration amongst PaaS providers, while the remaining respondents were almost equally distributed between preferring having migration as a service (47.57 %) and preferring the PaaS solution

to provide tools for migration (46.6 %).

### 3.3 Non-compensatory Behavior

Within the screening section, 35.92 % of the participants regarded an SDK as a must-have feature of PaaS solutions, while 4.85 % regarded an online development environment as a must-have feature. More than 40 % indicated that a PaaS solution not offering a development environment is unacceptable. Of the participants, 14.56 % regarded a test environment as a must-have feature; hence 15 participants regarded not offering a test environment as unacceptable. By contrast, 11.65 % of the participants thought that tools for migration among PaaS providers must be offered by a PaaS and 12.62 % of the participants regarded not offering any migration support as unacceptable. In terms of pricing, almost 5 % of the participants stated that revenue sharing was not an acceptable pricing model for them.

### 3.4 Relative Importance

The relative importance for each attribute category is depicted in Figure 2. By far the biggest importance (23.84 %) was attached to the development environment, followed by the test environment (14.15 %) and migration among PaaS providers (12.63 %). Pricing (8.79 %), mobile device access via app (8.77 %) and community features (8.54 %) were a little less important to the participants. Market penetration (6.77 %), marketplace functionalities (6.32 %), payment handling by marketplace (5.38 %), and monitoring (4.81 %) tailed the field.

The importance for each of the features above is an implicit value derived from the absolute range between the highest and the lowest part-worth utility of an attribute. Part-worth utilities for the attribute levels are normalized HB estimates and are depicted in Table 2 and Figure 3.

The higher the part-worth utility, the stronger the respondents' preference was for a certain attribute level. Since normalized part-worth utilities add up to zero for every single attribute, negative part-worth utilities indicate less-desired levels [10].

In addition to the relative importance of the attributes and the part-worth utilities, hierarchical Bayes estimation generates two statistics indicating the "goodness of fit" for every iteration [11]. The percentage certainty for the iterations in this data set has a mean of 0.470, indicating a goodness of fit of approximately 47 %. Almost the same result is obtained by looking at the root

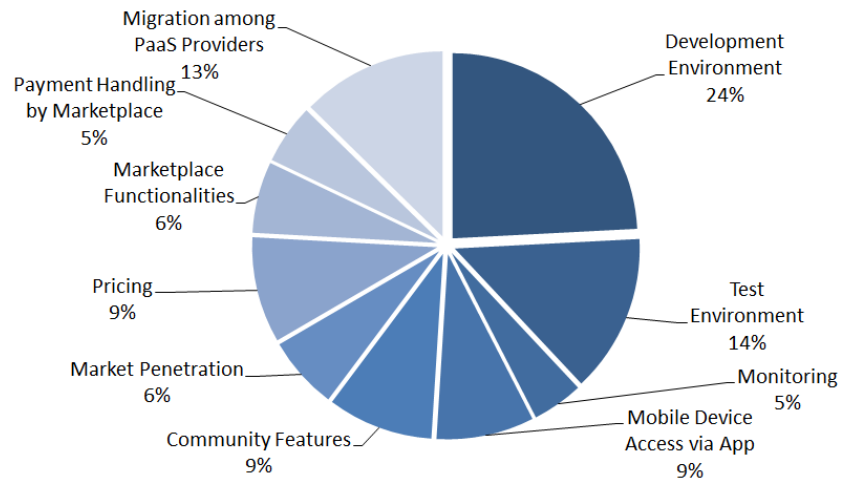


Figure 2: Relative importance of attributes based on the part worth utilities

likelihood (RLH): because each choice task has three alternatives, the RLH for a chance model would be 1/3. The actual value has an average of 0.654; therefore it can be interpreted as two times better than the chance level.

### 3.5 Interpretation

Based on the outcomes of the literature review, the focus group discussion and expert interviews, today's favored PaaS solutions should include the following features: availability of at least 95%, fully automated scalability, standardized APIs, high security standards and access control, and backup and disaster recovery. These are clearly the must-have features of PaaS solutions.

A development environment that is provided either online (50.28) or preferably as an SDK (68.73) can also be considered as a must, especially since 40 % of the participants indicated that a PaaS not offering a development environment is unacceptable. With a relative importance of 14 %, the same is true for the availability of a test environment, which was also indicated to be a

must-have feature by 15 participants. With a relative importance of 13 %, smooth migration among PaaS providers is of high significance to consumers. Thereby, consumers prefer PaaS solutions to offer the migration itself as a service (36.96), not just provide tools to support the migration process (28.78). In addition to this, 13 participants explicitly stated that not providing migration support is non-compensatory for them.

Although in the literature it is often claimed that PaaS is characterized especially by a pay-per-use model [12–15], the difference of consumer preferences between a pay-per-use pricing model (12.60) and a monthly flat-fee (8.51) is not that big. Revenue sharing was considered least attractive (-21.12). Also, 19.42 % of the respondents mentioned revenue sharing as their preferred pricing model within the build your own section of the questionnaire. These results seem somehow contradictory. One could assume that there are other factors influencing the preferred pricing model, like for instance the type and focus of the PaaS platform itself.

Attribute	Attribute Levels	Part-Worth Utility	Standard Deviation
Development Environment	• Online	52.97	73.48
	• SDK (offline)	66.43	76.42
	• None	-119.39	70.21
Test-Environment	• Yes	65.33	50.04
	• No	-65.33	50.04
Monitoring	• Customizable	11.04	24.79
	• Predefined	-11.04	24.79
Mobile Device Access via App	• Full Control	27.61	34.86
	• Monitoring	8.80	22.10
	• None	-36.41	36.86
Community Features	• Business-related Social Network	2.60	35.81
	• Knowledge Sharing	32.97	36.48
	• None	-35.57	27.28
Market Penetration	• High	27.26	35.20
	• Low	-27.26	35.20
Pricing	• Revenue Sharing	-21.12	43.13
	• Subscription	8.51	49.41
	• Pay per Use	12.60	38.29
Marketplace Functionalities	• Marketplace incl. Provisioning and Linkage to other popular marketplaces	13.00	25.95
	• Marketplace incl. Provisioning	-24.62	28.88
	• Marketplace incl. Linkage to other popular Marketplaces	11.62	27.51
Payment Handling by Marketplace	• Payment is handled by Marketplace	11.88	30.28
	• Information about Usage only	-11.88	30.28
Migration among PaaS Providers	• Migration as a Service (by click or as a Consulting Service)	36.96	35.30
	• Tools (e.g. import)	28.78	37.51
	• None	-65.74	34.74
"None" option		57.94	139.08

Table 2: Part-worth utilities of the attribute levels

Contrary to the assessments of the experts interviewed, mobile device access obtained a relative importance of more than 9 %. Although all the experts agreed that mobile device access to a PaaS solution would be less significant, consumers clearly prefer to have full control (27.61) via a mobile device instead of having only monitoring features available on mobile devices (8.80). With relative importance of 9 %, consumers do have a distinct interest in community features. However, they clearly focus on knowledge-sharing

features (32.97) and are less interested in socially enhanced features (2.60).

#### 4. SAP'S ENGINEERING RESPONSE

SAP provides the broadest Cloud solutions portfolio in the industry and offers solutions for all types and sizes of businesses, whether they are current SAP customers or new to the SAP family. We believe the full potential of cloud computing can only be realized if cloud solutions enable end-to-end business processes. Therefore, SAP delivers a

comprehensive application development Platform as a Service (aPaaS). Developers can use this platform to build new, on demand transactional applications as well as lightweight application extensions to existing on premise and on demand applications. The SAP OnDemand Platform will leverage the power of SAP HANA to enable fundamentally new types of applications. With the SAP Store, we offer a full-fledged commercial infrastructure that will allow partners and customers to manage the entire applications built on the platform.

SAP Business ByDesign Studio is our development environment that runs in combination with our SaaS solutions, e.g. SAP Business ByDesign as a complete on demand suite (the same concept applies for SAP Sales OnDemand, our line of business solution for sales automation, whereas the SDK is called SAP Cloud Developer Studio). In general the SDK is built to extend the reach of the underlying SAP solution in terms of fulfilling customer-specific requirements (the "last mile"), legal requirement or industry best-practices ("micro-verticals"). Hence, it "plays" in three disciplines:

1. Extensibility: extend existing user interfaces (including forms and reports) and business functionality.
2. Integration: integrate with external web services and mashups.
3. New application development: develop complementary software that is not in scope of the software provided by SAP



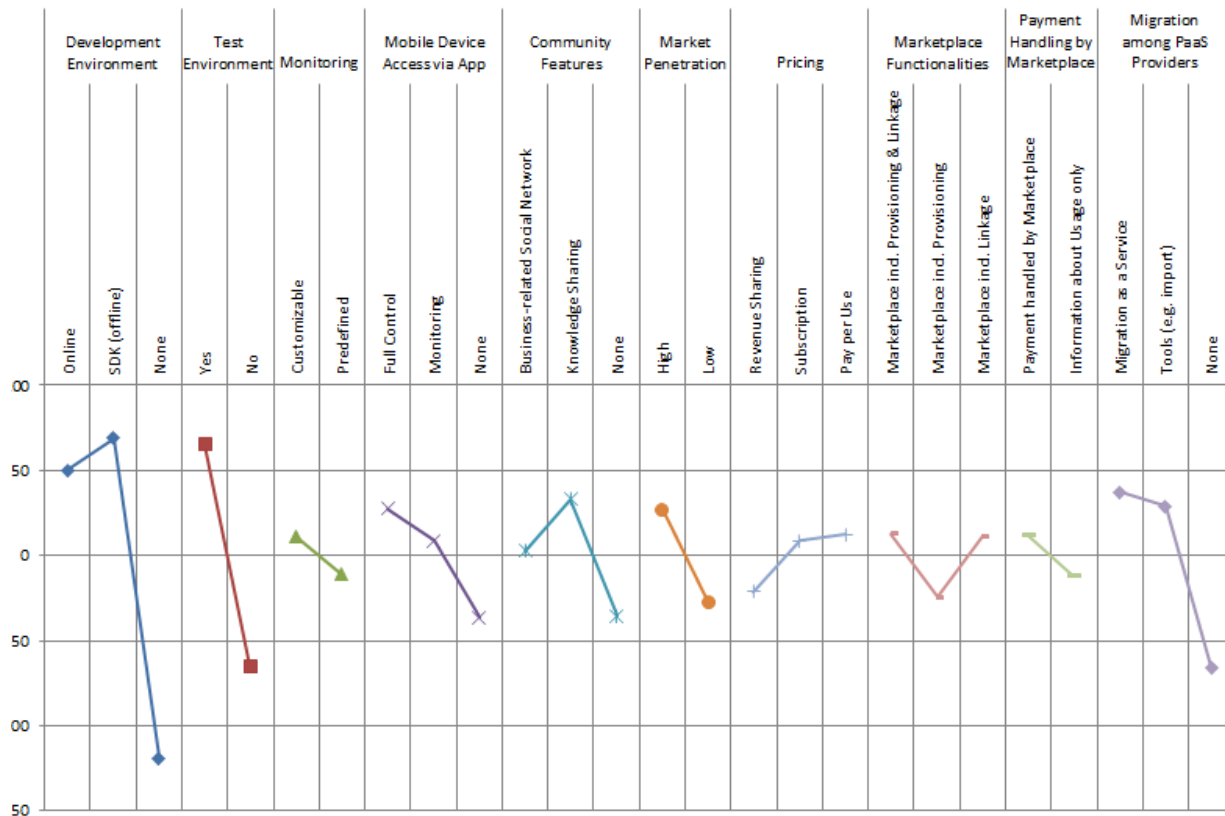


Figure 3: Chart of the part-worth utilities of each attribute level

SAP Business ByDesign Studio can be classified as a metadata aPaaS. A metadata aPaaS abstracts away the concept of server and physical database instances using metadata. Developers create metadata (such as custom data objects, code, and presentation elements) in visual programming environments that is interpreted by the aPaaS at runtime. Working at the highest abstraction level, metadata aPaaS enables users (including non-developers) to customize prebuilt templates.

SAP Business ByDesign Studio provides a web-based online development environment for selected content types that are considered to be developed by “key users”. These content types include extension fields, UI adaptations, (print) forms, and (analytical) reports. For more

sophisticated content, such as custom business logic, new user interfaces and web service integration, SAP Business ByDesign Studio provides an offline development environment (SDK, based on MS Visual Studio). The result of this study indicates that customer would expect even more content types available in an online, web-based tool set.

Content classified as “key user” content can be developed directly in a production environment, but it can be also be implemented in a development or test environment. For more sophisticated content, development in a development or test environment and transferred to the production environment after task completion and testing. For the test environment attribute evaluated in this study, SAP Business ByDesign fulfills the

highest level of expectation, including offerings for private cloud editions, which are not subject of this study.

SAP Business ByDesign Studio is a good fit when developing structured data-driven interactive business applications, in particular when accessing services of the SAP Business ByDesign SaaS platform with hundreds of released business objects, and its numerous UIs, analytical data sources and web services. Applications that extend existing investments in SAP Business ByDesign, SAP Sales OnDemand, or another SAP cloud solution are of particular value because the access to business data is optimized. As the SDK was designed as an integral piece of the particular solution proprietary technologies in the level of language, framework, container, and

hosting are used. Skills in these technologies need to be developed accordingly. However, as the SDK is based on MS Visual Studio and the development language is similar to Java and C#, the time to get on board is typically short.

If migration among PaaS providers is a preferred option and the cloud-based apps is independent of a SAP SaaS offering, SAP HANA Cloud<sup>1</sup> is the preferable option. SAP HANA Cloud is an open, standards-based and modular Platform as a Service for rapid development of on demand applications. SAP HANA Cloud supports for Java 6 Web Profile and Java 7 and comes with a number of services, such as persistency service, federated identity management, document and email services, and connectivity services for OnDemand-OnPremise connectivity. SAP HANA Cloud provides an offline development environment (SDK, based on Eclipse), and it supports test environments.

Both, custom solutions built with ByDesign studio and with SAP HANA Cloud can be made available in the SAP Store (<https://store.sap.com>). The “myAccount for Solution Providers” within the SAP Store is then being used to publish, sell and deliver their solutions. Solution Providers can

- view, describe and publish their solutions on the SAP Store,
- view customer orders and update order status, and

- view, monitor and respond to customer inquiries.

For enterprise software customers the SAP Store offers a “consumer-grade” App Store experience, thus setting new standards in the world of enterprise software: The Store can be easily accessed through multiple routes, solutions can be easily discovered, instantly purchased and delivered. It is available on the Web, for tablet computers and for smartphones – where and how SAP customers do business.

The SAP Store offers a wide range of capabilities supporting the See-Try-Buy-Deploy experience in an Enterprise environment:

**See:** The User experience is optimized for different platforms like desktop, tablet computer, or smartphone, based on a HTML5 responsive design. The SAP store facilitates in-product positioning: e.g. integration into SAP Business ByDesign and SAP Business Suite UI that allows positioning of context-specific, personalized recommendations from the SAP Store to end users. SAP’s Solution catalog includes faceted search, multimedia content, rating and reviews, as well as a Recommender Engine that provides personalized recommendations to SAP Store users.

**Try:** Via the SAP Store users get access to Test drive of cloud solutions and trial versions and are provided with Tele interactions like “chat with me” or “call me back” options.

**Buy:** The SAP Store allows Online ordering applying localized terms & conditions and

offers various pricing schemes for user-based, one-time and subscription pricing. The platform also facilitates sales of bundles of complementary license products, credit card payment and/or invoicing, and provides the “MyAccount” workcenter for customers to review their previous orders.

**Deploy:** The SAP Store directly triggers the deployment of cloud solutions. In addition to this a Download Management is offered that supports software logistics for OnDevice and OnPremise software incl. license management integration together with SAP Service Marketplace.

In addition to the capabilities outlined, the SAP Store reflects specific requirements of enterprise customers and enterprise software purchasing processes. These capabilities are largely unique in the industry and go far beyond traditional consumer app stores:

- Quality checks not only for SAP software but also by partner products. SAP Store customers are guaranteed to find products that are certified by SAP.
- Online compatibility checks to confirm to the customer that a product will function in his system.
- Corporate buying roles and processes that allow only selected individuals to purchase on behalf of their companies.
- Corporate discounts and other specific terms applied to online transactions.
- Orders for volumes of user licenses and the need for distributing software to end users after purchase.

<sup>1</sup>

<http://scn.sap.com/community/developer-center/cloud-platform>

- Co-existence and integration with other sales channels within SAP and its ecosystem, incl. defined handover points between channels.

## 5. CONCLUSION

The purpose of the paper at hand was to determine developers' preferences on PaaS solutions and to present SAP's engineering response. In that regard, platform as a service has been defined as execution environments wherein external developers deploy and run their components. PaaS also facilitates the development, testing, and management of software components, as well as the exchange of knowledge between developers. This study has shown that PaaS solutions that aim to attract software developers have to fulfill certain needs and expectations. In particular, PaaS solutions should contain a sophisticated development environment (online or offline), offer a service for the importing of data and/or software during migration among different PaaS providers, and include a reliable test environment. They furthermore need to meet prevailing security, reliability, scalability, standardization and mobile access requirements.

SAP meets developers' preferences on Platform as a Service by the following solutions: SAP's OnDemand Platform is a comprehensive application development PaaS, that allows developer to build new, on demand transactional applications as well as lightweight application extensions.

SAP Business ByDesign Studio is our development environment

that runs in combination with our SaaS solutions, e.g. SAP Business ByDesign as a complete on demand suite. The Studio allows 1.) to extend user interfaces, 2.) to integrate with external web services and mashups, as well as 3.) to develop comprehensive applications. SAP Business ByDesign Studio provides an offline development environment (an SDK, based on MS Visual Studio), as well as a web-based online development environment for selected content types that are considered to be developed by "key users".

SAP HANA Cloud is an open, standards-based and modular Platform as a Service for rapid development of on demand applications. This platform based on Java comes with a number of services, such as persistency service, federated identity management, document and email services, and connectivity services. SAP HANA Cloud provides an offline development environment (an SDK, based on Eclipse), and supports test environments.

Custom solutions built with SAP Business ByDesign Studio or with SAP HANA Cloud can be made available in the SAP Store, where service providers can publish, sell and deliver their solutions.

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