

An Explorative Study of Mobile Apps in the Enterprise

Completed Research Paper

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Abstract

This research investigates the phenomenon of enterprise mobility through the lens of SAP mobile app store. SAP is a leading vendor in Enterprise Resource Planning (ERP) system, and app stores are digital platforms that provide users a central location to effectively browse, purchase, download, and update their mobile applications. By surveying the ERP mobile apps available in SAP mobile app store, this study examines the market structure of mobile apps and the factors that influence their adoption. In addition, the study incorporates the interviews of two ERP mobile app providers to help understand the influential factors in enterprise mobility adoption and the business benefits associated with enterprise mobility. Future research directions are discussed.

Keywords

Mobility, ERP, Mobile Apps, Adoption.

Introduction

According to a recent survey conducted by the Pew Research Center's Internet & American Life Project, over 56% of American adults are now smartphone¹ owners. Indeed, growing at 10 times the rate at which personal computer was adopted in 1980s, smartphone adoption is considered the fastest in the history of consumer technology. In addition, the market research conducted by IDC indicates that the tablet shipments surged 75% in the fourth quarter of 2012 while PC market declined during the same quarter for the first time in more than five years. These numbers indicate that smart devices and technology have drawn strong interest from both consumer and business users. Indeed, one Gartner study suggests that smart phone and tablet usage is rising rapidly in enterprises, it is predicted that tablets purchased by businesses alone will reach 53 million units by 2016, and enterprise mobility is destined to change the very nature of how employees do their work.

Even though hardware improvement related factors, such as better processing power, larger wireless network bandwidth etc., have contributed to the popularity of smart mobile devices, fundamentally, it is the ability to run a large selection of feature-rich mobile applications that really differentiates "smart" mobile devices from "dumb" ones (Charland, 2011; Holzer and Ondrus, 2011). Not surprisingly, as the demand for business use of smart devices surges, so too will be the interest in enterprise mobile applications and services.

This research attempts to investigate the phenomenon of enterprise mobility through the lens of SAP mobile app store. SAP is a leading vendor in Enterprise Resource Planning (ERP) system (Ranganathan

¹ According to the survey, smart phone include the iPhone and Blackberry, as well as phones running the Android, Windows or Palm operating systems.

and Brown, 2006), and app stores are digital platforms that provide users a central location to effectively browse, purchase, download, and update their mobile applications. There is no doubt that app stores play critical roles in driving mobile app adoption and usage. By surveying the enterprise mobile apps available in SAP mobile app store, we intend to examine the current state of its market structure and factors that influence its adoption. In addition, we incorporated the interview data of two ERP mobile app providers to better understand the issues surrounding its adoption and impact in enterprises.

Literature and Research Questions

Enterprise-wide resource planning (ERP) system software packages are widely adopted, highly integrated, and complex systems for businesses (Gargeya and Brady, 2005). ERP system integrates various business processes from human resources, accounting, finance, sales, manufacturing, distribution and supply-chain management under one unified interface across the entire enterprise. On the one hand, ERP systems promise tremendous benefits, including competitive advantages, operational efficiencies, and tightened supply chain integration (Bingi et al., 1999; Chen et al., 2009). On the other hand, ERP implementation in general is challenging and its high failure rate has been attributed to various factors, including user resistance to organizational change, data quality issues, as well as learning curve and user-training related problems (Robey et al., 2002; Gargeya and Brady, 2005; Xu et al., 2002).

In many ways, mobile technology holds tremendous promise for enterprise system to reinvent its user interfaces and improve user experiences. In general, mobile applications are very different from their desktop counterparts. Because they tend to be used in short spurts, more frequently, but with limited screen size, it is important for mobile applications to deliver simple and focused functionalities for accomplishing specific tasks, rather than general and complex features in a combined fashion (Salmre, 2005). In addition, modern smartphones are equipped with a touch screen and embedded sensors that are traditionally not part of desktop computers, such as an accelerometer, digital compass, gyroscope, GPS navigation, microphone, and camera, it's possible for developers to create a large array of exciting applications to address virtually every aspect of mobile users' personal as well as professional needs. Since mobile applications first debuted in Apple's app store and Google's Android Market in 2008, there has been an explosion in innovative mobile apps (Lane et al., 2010). Some popular mobile app categories include games, music, banking, and shopping. However, most studies in this area appear to be focusing on the consumer oriented mobile apps, we argue that enterprise mobility, as a more recent phenomenon, deserves special attention because it may redefine and expand the roles that enterprise systems play in organizations.

The popularity of smartphone-enabled mobile apps is a consumer phenomenon. We argue that consumer-oriented industries will be very interested in adopting enterprise mobile solutions to keep pace with their customers. In order to respond to this demand, ERP vendors are going to develop more enterprise solutions in these industries. Answering the following questions will help ERP vendors' development efforts.

- How enterprise mobility market is currently structured? Are there more mobile apps readily available for some industries than others?

Business areas that support mobile workers who constantly travel potentially need to use the enterprise mobile solutions most frequently. This indicates that functions such as sales and plant maintenance could be among the ones that get mobilized first. Considering the impact in terms of the number of people that is going to benefit from mobile solutions within organizations, the business areas that service most number of employees in the organization should also be targeted. Function like human resource could be an example of the latter case. The answers to the following questions will help us examine these arguments.

- How mobility is currently adopted in the enterprise? Are there any business areas that enterprises choose to mobilize first?

This research will investigate impact of ERP system maturity, app complexity, business areas, pricing model on enterprise mobility adoption to answer the following question:

- What are influential factors in enterprise mobility adoption?

Since mobile devices are easier to carry, providing access to enterprise systems anywhere anytime, we expect productivity gains and improved user experience with enterprise software. Thus, we explore:

- What are the business benefits associated with enterprise mobility? Why companies choose to implement it?

Research Method and Data Analysis

We strive to answer these research questions through the lens of the SAP mobile app store. The information about two hundreds and four (204) mobile apps available at the SAP app store from March 2012 to January 2013 was collected. The data was analyzed based on the time (i.e., the month) that each app was available at the store. The distribution of the apps across the month is reported in Figure 1.

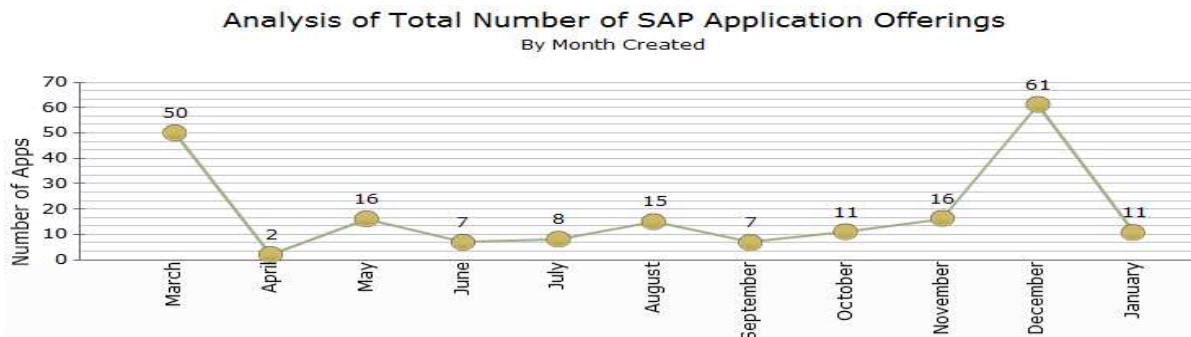


Figure 1. The Mobile Apps Posted Across time

The information collected for each app includes: the industries covered (sometimes multi-industries), business areas applied, the supported devices and platforms (operating systems), the number of downloads each month, listed price, and the pricing model.

Results and Managerial Insights

The market structure of enterprise mobility is examined by (1) the industries that a mobile app is intended to cover, (2) the business areas that a mobile app has applied to, and (3) the supported devices supporting operating systems or platforms.

The Industries Covered

Each mobile app has indicated its target industries. Table 1 reports the number of mobile apps in each industry over time, the growth rate of the apps, and the percentage of apps. The growth rate is estimated based on the cumulated number available each month. The percentage is calculated on the base of total available apps at the store. Each app could cover as many industries as it has been developed for, making the total percentage not equal to 100%. This coverage ranges from 1 to 24 with the means as 2.45 industries per app. Some apps offer a platform that allows the integration for applications from multiple industries. This is categorized as “Multi-industries”. All 204 mobile apps have covered twenty five industry categories. This information is listed in the order of percentage with the largest one going first.

As observed from Figure 2, about 29% (146) apps are developed for the enterprises whose business may go across multiple industries with the growth rate at 10 apps per month. This number is significantly greater than that for any other single industry. However, this is not surprising. All enterprise information systems are targeted on integrating the so-called information islands within different organizational units. These units may be traditional functional areas such as accounting, finance, or human resource management. They may also go across different components of a supply chain. For example, a paper mill may have its own small forest as its emergency lumber supply base. In other cases, an OEM may suggest an enterprise information system to its suppliers or its retailers so that the information across the supply chain could be integrated smoothly.

The next two industries on the list are retail and consumer products. Retail industry has 35 mobile apps, accounting for 7.0% of the total apps coverage. Its growth rate is 3.07 apps per month. Consumer products industry has 31 mobile apps (accounting for 6.2%) with its monthly growth rate as 1.79 apps.

Three industries have mobile apps between 20 and 30. Industrial machinery & components has 25 (5.0%) mobile apps. The area of Engineering, Construction & Operations has 23 apps (4.6%). High tech has 20 apps (4.0%). Thirteen industries have mobile apps ranging from 10 to 19. Six industries have mobile apps less than 10. Among these six industries, higher education & research has only one app so far.

| Industry | 03-12 | 04-12 | 05-12 | 06-12 | 07-12 | 08-12 | 09-12 | 10-12 | 11-12 | 12-12 | 01-13 | G. Rate | Total (%) |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|-------------|
| Multi-Industries | 40 | 2 | 9 | 7 | 5 | 10 | 5 | 3 | 13 | 43 | 9 | 10.00 | 146 (29.2%) |
| Retail | 5 | 0 | 4 | 0 | 2 | 3 | 0 | 7 | 3 | 10 | 1 | 3.07 | 35 (7.0%) |
| Consumer Products | 10 | 1 | 4 | 0 | 1 | 1 | 0 | 0 | 3 | 9 | 2 | 1.79 | 31 (6.2%) |
| Industrial Machinery & Components | 8 | 0 | 4 | 0 | 1 | 3 | 0 | 0 | 2 | 6 | 1 | 1.62 | 25 (5.0%) |
| Engineering, Construction & Operations | 5 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 2 | 9 | 2 | 1.56 | 23 (4.6%) |
| High Tech | 5 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 3 | 5 | 2 | 1.25 | 20 (4.0%) |
| Oil & Gas | 6 | 0 | 3 | 0 | 1 | 2 | 0 | 0 | 1 | 5 | 1 | 1.21 | 19 (3.8%) |
| Healthcare | 5 | 0 | 3 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1.24 | 18 (3.6%) |
| Life Sciences | 7 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0.92 | 18 (3.6%) |
| Wholesale Distribution | 3 | 0 | 3 | 0 | 1 | 2 | 1 | 0 | 1 | 6 | 1 | 1.43 | 18 (3.6%) |
| Automotive | 2 | 0 | 1 | 0 | 1 | 2 | 0 | 0 | 2 | 8 | 1 | 1.40 | 17 (3.4%) |
| Chemicals | 4 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 1 | 5 | 2 | 1.05 | 16 (3.2%) |
| Transportation & Logistics Services | 4 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 4 | 2 | 0.82 | 14 (2.8%) |
| Utilities | 2 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 1 | 7 | 0 | 1.11 | 14 (2.8%) |
| Aerospace & Defense | 2 | 0 | 1 | 0 | 1 | 2 | 0 | 0 | 1 | 3 | 1 | 0.88 | 11 (2.2%) |
| Mill Products | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 1 | 4 | 1 | 0.91 | 11 (2.2%) |
| Professional Services | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 4 | 0 | 0.76 | 11 (2.2%) |
| Telecommunications | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 5 | 1 | 0.83 | 11 (2.2%) |
| Mining | 2 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 1 | 2 | 1 | 0.75 | 10 (2.0%) |
| Public Sector | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 4 | 0 | 0.70 | 8 (1.6%) |
| Banking | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0.44 | 6 (1.2%) |
| Defense & Security | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 2 | 1 | 0.59 | 6 (1.2%) |
| Insurance | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0.44 | 5 (1.0%) |
| Media | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0.35 | 5 (1.0%) |
| Higher Education & Research | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.08 | 1 (0.2%) |

Table 1. Industry Covered by Enterprise Mobile Apps

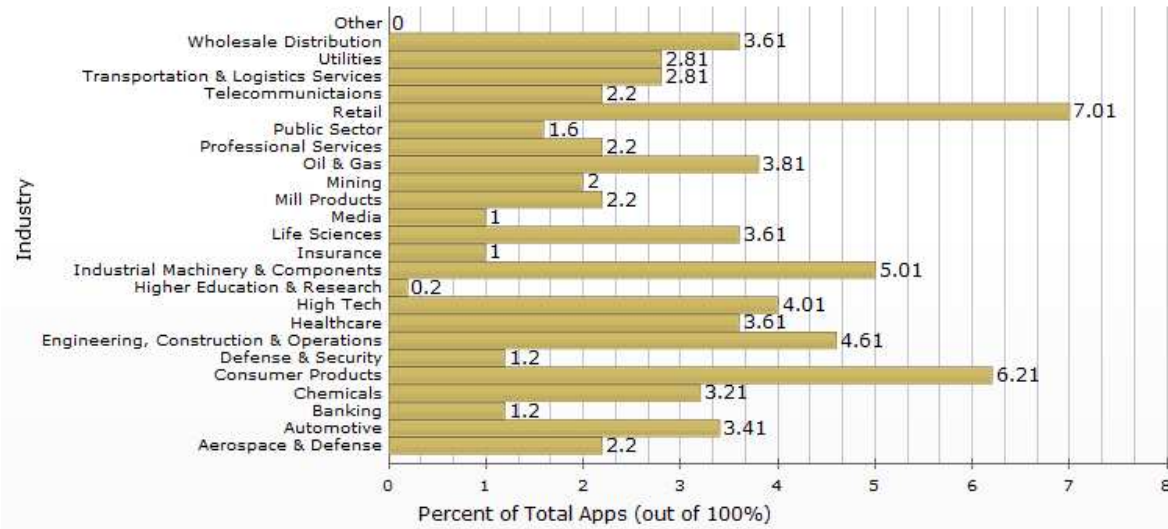


Figure 2 Enterprise Mobile App by Industry

Business Areas Applied

Table 2 summarized the business areas applied by 204 mobile apps. Each mobile app has its major intended business area(s) specified. Among 204 apps, each app covers a minimum of one and a maximum of eleven business areas with the average of 2.31 business areas to be applied.

From this perspective, sales (17.4%), customer service (13.8%), and human resources (10.2%) are the top three business areas that are the targeted areas of the mobile apps. A total of 65 mobile apps have been developed for the customers in sales area. In terms of growth rate, sales (6.05), customer service (4.64), and information technology (3.89) are the top three areas that have been covered by mobile apps. Each month, additional 6.05 mobile apps are developed for sales use.

| Business Area | 03-12 | 04-12 | 05-12 | 06-12 | 07-12 | 08-12 | 09-12 | 10-12 | 11-12 | 12-12 | 01-13 | G. Rate | Total (%) |
|---------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|------------|
| Sales | 18 | 2 | 4 | 1 | 3 | 5 | 2 | 9 | 3 | 31 | 4 | 6.05 | 82 (17.4%) |
| Customer Service | 15 | 0 | 2 | 2 | 3 | 4 | 2 | 1 | 6 | 25 | 5 | 4.64 | 65 (13.8%) |
| Human Resources | 22 | 0 | 4 | 3 | 0 | 1 | 1 | 0 | 4 | 11 | 2 | 2.35 | 48 (10.2%) |
| Manufacturing | 7 | 0 | 2 | 1 | 2 | 5 | 1 | 1 | 2 | 22 | 4 | 3.67 | 47 (10.0%) |
| Supply Chain Management | 10 | 0 | 5 | 1 | 0 | 5 | 0 | 1 | 3 | 20 | 1 | 3.34 | 46 (9.8%) |
| Finance and Controlling | 15 | 0 | 2 | 2 | 2 | 5 | 1 | 8 | 3 | 6 | 1 | 3.34 | 45 (9.6%) |
| Information Technology | 6 | 0 | 1 | 4 | 1 | 6 | 4 | 0 | 6 | 15 | 0 | 3.89 | 43 (9.1%) |
| Procurement | 9 | 0 | 2 | 1 | 0 | 3 | 1 | 1 | 1 | 16 | 0 | 2.36 | 34 (7.2%) |
| Marketing | 7 | 0 | 0 | 1 | 1 | 3 | 0 | 0 | 2 | 9 | 1 | 1.65 | 24 (5.1%) |
| R&D / Engineering | 4 | 0 | 3 | 1 | 0 | 1 | 0 | 0 | 2 | 12 | 0 | 1.69 | 23 (4.9%) |
| Corporate Strategy and Sustainability | 6 | 0 | 2 | 2 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 0.79 | 14 (3.0%) |

Table 2. Business Areas Applied by Enterprise Mobile Apps

Supported Devices and Supporting Platforms (Operating Systems)

SmartPhone and Tablet are the two devices for mobile apps. Ninety nine apps are developed for SmartPhone alone and sixty for Tablet alone. Forty four apps are developed to work on both. One mobile app in the store didn't report the supported device.

About 49% apps (143) are developed for SmartPhone with a 9.63 apps monthly growth rate. This suggests that SmartPhone will still be the major hosting device of mobile apps. Tablet is hosting about 36% of the mobile apps with a 8.60 apps monthly growth rate. The growth rate for apps that could be run on both devices is 3.49 per month.

Four apps were specified to be hosted by SmartPhone but did not indicate any platforms or operating systems they were running. Among the remaining 139 apps, each app can run on a minimum of one and a maximum of five operating systems with an average of 1.42, suggesting the flexibility of choosing operating systems to install apps (see Table 3).

| | 03-12 | 04-12 | 05-12 | 06-12 | 07-12 | 08-12 | 09-12 | 10-12 | 11-12 | 12-12 | 01-13 | G. Rate | Total (%) |
|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|--------------|
| Apple iOS | 30 | 0 | 8 | 3 | 5 | 6 | 3 | 2 | 8 | 34 | 2 | 6.85 | 101 (51.01%) |
| Google Android | 8 | 0 | 4 | 0 | 3 | 3 | 1 | 0 | 6 | 22 | 1 | 3.75 | 48 (24.24%) |
| Blackberry | 16 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 12 | 1 | 1.41 | 33 (16.67%) |
| Windows Phone | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 7 | 0 | 0.92 | 14 (7.07%) |
| Symbian OS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.16 | 2 (1.01%) |

Table 3. Operating Systems for SmartPhone

As shown in Table 3 and Figure 3, about half (51.01%) of the apps can run on Apple iOS operating system or platform, followed by Google Android (24.24%), Blackberry (16.67%), Windows Phone (7.07%), and Symbian OS (1.01%). The growth rate of the platform to be used by mobile apps followed the same order, starting from Apple iOS (6.85 apps per month) and ending with Symbian OS (0.16 apps per month).

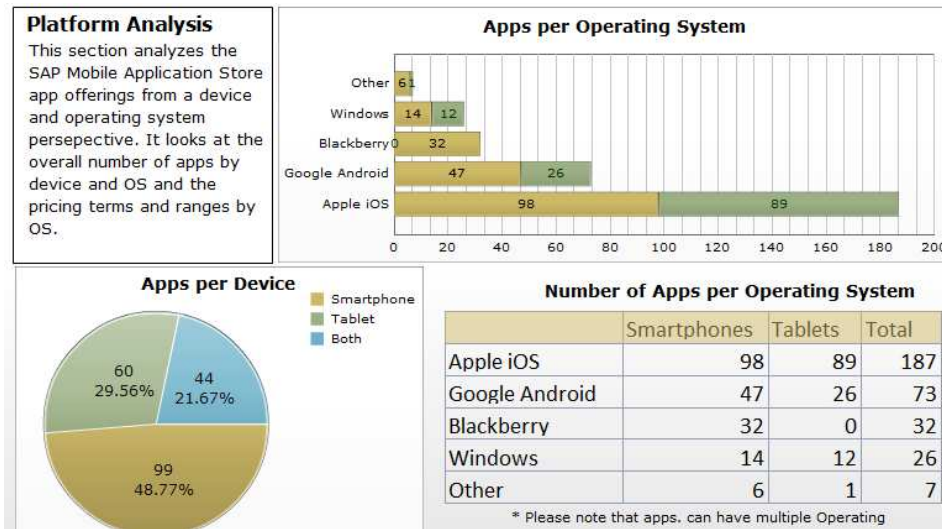


Figure 3. Enterprise Mobile Apps Platform Analysis

If the market structure of mobile apps could be viewed as the market readiness for business, then to what extent these mobile apps are adopted by enterprises? Are there any business areas that enterprise choose to mobilize first? When a mobile app is downloaded from the store, we assume that this app will be installed by a user and, thus, is viewed as adopted. This adoption number will help find out the business areas with large mobile users.

Mobile Apps Adoptions

We analyze the numbers separately for free apps and priced apps. For free apps, the total downloading number is 7125 with a 173 monthly growth rate. For priced apps, the total average downloading number is 933.53 with a 36 monthly growth rate as shown in Table 4. The downloading number reported in March 2012 is the cumulative number up to that month.

| # of Downloads | 03-12 | 04-12 | 05-12 | 06-12 | 07-12 | 08-12 | 09-12 | 10-12 | 11-12 | 12-12 | 01-13 | G. Rate | Total |
|----------------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|--------|
| Free Apps | 5377 | 64 | 350 | 370 | 153 | 223 | 41 | 17 | 48 | 453 | 29 | 173 | 7125 |
| Priced Apps | | | | | | | | | | | | | |
| Min. | 93 | 209 | 44 | 63 | 4 | 5 | 20 | 0 | 0 | 0 | 0 | | |
| Avg. | 461.27 | 209 | 129.2 | 63 | 4 | 28.17 | 29 | 0.3 | 4.8 | 3.12 | 1.67 | 36 | 933.53 |
| Max. | 1382 | 209 | 313 | 63 | 4 | 49 | 38 | 3 | 26 | 12 | 4 | | |

Table 4. The Number of Downloads by Price

Business Areas with Large Mobile Users and Quick Growth

Table 5 reports the number of downloads of mobile apps by business areas. The information in the table suggests the trends of user acceptance of mobile apps. The top three business areas that the mobile apps are accepted by users are human resources (19.76%), sales (13.46%), and finance and controlling (10.86%). However, customer service is the area that user acceptance grows quickest. Its monthly growth rate is 83.80 user apps, followed by human resources (83.15) and sales (72.53) areas. Again, the big numbers of downloads in March 2012 are the cumulative numbers up to that month. Some apps don't have any downloads in certain months.

| Business Area | 03-12 | 04-12 | 05-12 | 06-12 | 07-12 | 08-12 | 09-12 | 10-12 | 11-12 | 12-12 | 01-13 | G. Rate | Total (%) |
|---------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|---------------|
| Human Resources | 8962 | 0 | 457 | 143 | 0 | 29 | 6 | 0 | 16 | 289 | 0 | 83.15 | 9902 (19.76%) |
| Sales | 5903 | 273 | 165 | 63 | 49 | 139 | 26 | 3 | 17 | 105 | 4 | 72.53 | 6747 (13.46%) |
| Finance and Controlling | 4951 | 0 | 119 | 178 | 48 | 115 | 6 | 0 | 12 | 13 | 0 | 54.14 | 5442 (10.86%) |
| Customer Service | 3996 | 0 | 111 | 117 | 70 | 131 | 22 | 0 | 39 | 323 | 33 | 83.80 | 4842 (9.66%) |
| Marketing | 3595 | 0 | 0 | 63 | 5 | 107 | 0 | 0 | 9 | 286 | 1 | 46.53 | 4066 (8.11%) |
| Information Technology | 3019 | 0 | 31 | 299 | 17 | 128 | 44 | 0 | 46 | 57 | 0 | 70.45 | 3641 (7.27%) |
| Corporate Strategy and Sustainability | 3145 | 0 | 200 | 178 | 0 | 29 | 0 | 0 | 8 | 5 | 0 | 41.02 | 3565 (7.11%) |
| Procurement | 2832 | 0 | 71 | 63 | 0 | 126 | 6 | 17 | 8 | 75 | 0 | 39.85 | 3198 (6.38%) |
| R&D / Engineering | 2784 | 0 | 84 | 63 | 0 | 29 | 0 | 0 | 9 | 24 | 0 | 20.65 | 2993 (5.97%) |
| Supply Chain Management | 2426 | 0 | 172 | 63 | 0 | 209 | 0 | 17 | 12 | 57 | 2 | 57.67 | 2958 (5.90%) |
| Manufacturing | 2242 | 0 | 112 | 63 | 25 | 198 | 19 | 17 | 9 | 59 | 15 | 57.46 | 2759 (5.51%) |

Table 5. User Downloads by Business Areas

The third research question is addressed by examining the pricing structure, listed prices, as well as estimated revenues of enterprise mobility market, as represented by SAP mobile app store.

Identification of Influential Factors in Enterprise Mobility Adoption

Based on data collected and observations above, we hypothesize that adoption of enterprise mobility is influenced by ERP system maturity, scope of impact, app flexibility, and perceived app quality. ERP system maturity is measured by the number of SAP components required for an app, app complexity is measured by the number of technical requirements, scope of impact is measured by the number of business areas covered, flexibility is measured by the number of platforms an app supports, and perceived quality is measured by the app review rating, number of reviews, and number of white papers.

$$Y_{adoption} = \mu + X_{ERPmaturity} + X_{Complexity} + X_{Price} + X_{Scope} + X_{Flexibility} + X_{Industry} + X_{CustRating} + X_{Reviews} + X_{WhitePaper} + \square$$

Liner regression analysis was conduct and results indicated the model is significant at $\alpha = 0.05$ level as shown in Tables 6 and 7 below. In summary, enterprise mobility adoption is statistically influenced by the ERP system maturity, scope of impact of an mobile app, number of app reviews, and number white paper published at $\alpha = 0.05$ level.

| Model | Sum of Squares | df | Mean Square | F | Sig. | R | R Square | Adjusted R Square |
|--------------|----------------|-----|-------------|-------|-------|-------|----------|-------------------|
| 1 Regression | 2980439.491 | 9 | 331159.943 | 9.786 | .000b | .610a | .371 | .334 |
| Residual | 5042419.616 | 149 | 33841.742 | | | | | |
| Total | 8022859.107 | 158 | | | | | | |

Table 6. Summary of Liner Regression Model

| | Unstandardized Coefficients B | Std. Error | Standardized Coefficients (Beta) | t | Sig. |
|-----------------|-------------------------------|------------|----------------------------------|--------|---------------|
| (Constant) | -105.500 | 62.636 | | -1.684 | .094 |
| ERPMaturity | -2.413 | 4.091 | -.039 | -.590 | .556 |
| Complexity | 22.945 | 13.688 | .130 | 1.676 | .096** |
| Price | .000 | .013 | -.001 | -.022 | .982 |
| Scope | 17.027 | 6.232 | .193 | 2.732 | .007* |
| Flexibility | 11.383 | 37.243 | .022 | .306 | .760 |
| IndustrySupport | -6.452 | 4.449 | -.097 | -1.450 | .149 |
| CustRating | -50.038 | 27.283 | -.198 | -1.834 | .069** |
| Reviews | 335.933 | 69.650 | .530 | 4.823 | .000* |
| WhitePapers | 70.843 | 17.485 | .306 | 4.052 | .000* |

* Significant at $\alpha = 0.05$ level

** Significant at $\alpha = 0.10$ level

Table 7. Coefficients and Model Details

Scope of Impact and Enterprise Mobility Adoption

The statistical results indicate that scope of impact measured by the number of business areas an app supports plays an important role in enterprise mobility adoption because business benefits realized through its border impact. The more business areas and employees can benefit from the adoption of a business solution, the more likely that an enterprise will adopt the proposed solution. Further review of data collected, the results are supported by the evidence that the bussiness areas with the most mobile apps and users are traditional high impact areas such as sales, customer service, human resources, manufacturing, and supply chain management, as shown in Figure 4.

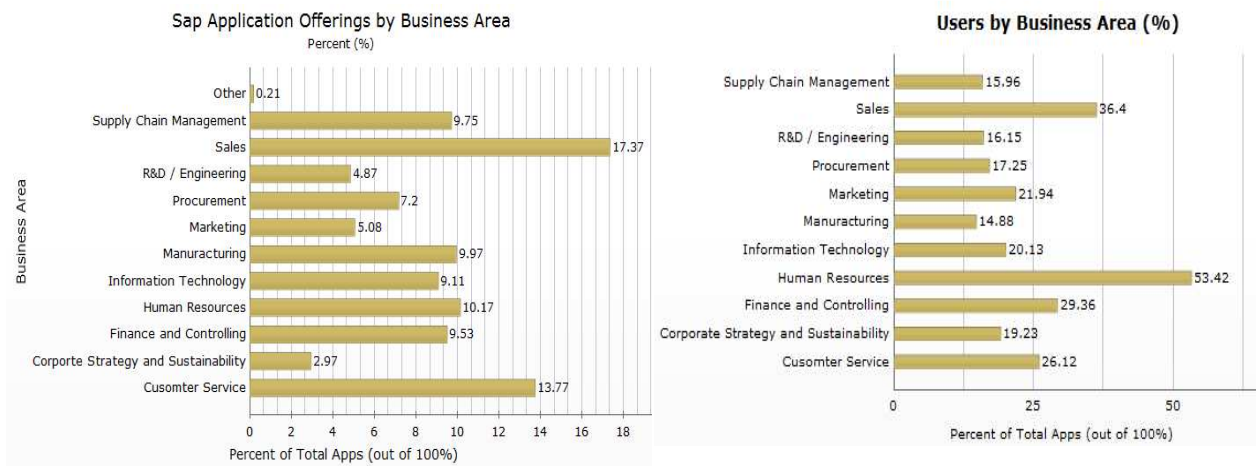


Figure 4. Total Apps Offering and User Downloads by Business Area

What benefits these apps will bring to the adopting organizations? To better understand results and bridge gaps between academic research and industry application, we interviewed a solution manager from the SAP mobility division, and the founder of a third party mobile app provider whose apps are sold in SAP mobile app store. The manager used three examples to illustrate the benefits of enterprise mobility and explain why enterprises need to provide mobile solutions for their employees.

Business case 1: The traditional SAP ERP system is a desktop-based application. A lot of times, data is first filled on paper then entered into the system manually by another person. One of the biggest benefits of enterprise mobility is to expand the ERP's reach to those employees who previously do not have direct access to SAP system in the enterprise. According to the SAP solution manager:

With mobile, you can certainly reach a lot more people of your enterprise...you can offer them self-services that allow them to access data that are relevant to them and business processes they are actually involved in.

Business case 2: The manager uses the following example to vividly explain why companies would choose to mobilize its asset management function and enable self-services for those employees who tend to be "out in the field".

Let's say I work for a telecom company to maintain pipelines, I have all my schedule right there on my phone or tablet, I know where to go, when to be there, what tools to bring. I have the manual for whatever I need to maintain, you can visualize it on the mobile application for things like: how many times do I have to move the wrench and how much torque do I have to apply? I know what parts not to touch because it's probably too hot for me....And of course, I can report back to headquarters what has been done or what has been wrong. An immediate status update can feed back to the enterprise without anyone actually going back to the enterprise...It reduces my training needs, and I just get the work done way more efficiently than ever before.

Business case 3: Business travel approval process is another area that enterprise mobility can make a broad impact that not only affects every employee of the company but also delivers real cost savings. From businesses' perspective, this revenue means the cost to purchase mobile apps.

If I want to book a flight as an employee and I know about two weeks before I want to fly, I think that's about the time where I get the best price. Now I submit that to my manager and I say I need that flight to be approved, and it takes him a day or two to even get that information because, well, maybe he's just traveling right now as well. So what happens? The price, instead of costing me \$800 to fly to Germany it might cost me \$1300. So mobility has just saved my company a couple of hundred dollars with one click. So that's really matters. and the infrastructure that companies need to have in place to make it[mobility] all happen, suddenly becomes very cheap in comparison, because the efficiency that they get out of mobility really offsets the cost by many times.

Number of Reviews and App Ratings in Enterprise Mobility Adoption

The results indicate that number of app reviews and number of white papers are influential to enterprise mobility adoption at $\alpha = 0.05$ level while the app rating is an influential factor at $\alpha = 0.10$ level. The researchers hypothesize that number of app reviews, app ratings, and number of white papers can be used as a perceived app quality index. The hypothesis is partially supported through a variable reduction analysis using Principle Components method and a reliability test using Cronbach's Alpha, as shown in Table 8 below.

| | Component | | | |
|-------------|-----------|-------|-------|-------|
| | 1 | 2 | 3 | 4 |
| Reviewers | .847 | .410 | -.037 | -.029 |
| CustRating | .794 | .496 | .039 | -.006 |
| WhitePapers | .630 | -.454 | .161 | -.020 |
| Complexity | .483 | -.639 | -.075 | .262 |
| Industry | .082 | -.324 | .804 | .130 |
| Scope | -.227 | .492 | .629 | .163 |
| ERPMaturity | -.062 | .142 | -.194 | .951 |

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|-------------|----------------------------|--------------------------------|----------------------------------|------------------------------|----------------------------------|
| Reviewers | 1.8079 | 1.986 | .663 | .637 | .320 |
| CustRating | 1.7006 | 1.245 | .406 | .622 | .289 |
| WhitePapers | .2542 | 1.282 | .225 | .076 | .703 |

Table 8. Factor Reduction and Reliability Analysis

The number of reviews and app ratings can be reasonably viewed as a quality index for an app as suggested by prior literature. As enterprise app review and ratings may exhibit different behavior pattern than personal app or product review, additional research in this area will be valuable. On the other hand, the number of white papers was included originally as a dimension of perceived quality index, but was removed later from the quality dimension in the reliability test. One of possible explanations is that the number of white paper may be perceived with the level of support or expertise of the app vendor and further research in this area would be valuable.

App Pricing and Enterprise Mobility Adoption

The results indicate that no significant statistical support ($p = 0.982$) is found that the app price is an influential factor for enterprise mobility adoption at $\alpha = 0.05$ level. One of possible explanations is that enterprise mobile apps incur significant integration cost in order to connect mobile apps with the backend ERP system and the integration and customization costs are often not reflected in the initial app price reported.

By reviewing the data collected, the pricing model can be classified into following five categories:

1. **“Free:”** This type of apps mainly serves marketing purposes, the app vendors may not have full-fledged product, but are willing to custom build solutions for potential customers who are interested.
2. **“Contact For Price:”** In most cases, the vendors of this type of apps have a product to offer and they know the cost of integration. They need to be contacted to negotiate the price.
3. **“One Time Per User:”** For this type of apps, the integration cost is most likely included in the app price, which varies significantly, running from \$38 per user to thousands of dollars per user. According to the SAP mobile solution manager, the price is directly correlated with the app complexity and the effort it takes to be integrated with the backend system.
4. **“One Time:”** This pricing model also charges its customer only once. After that, the customers are free to deploy the apps to as many employees as they want.
5. **“Per User Per Month:”** This is a subscription-based pricing model. Its customer is charged on a monthly basis.

With the type of “Free” and “Contact for Price” apps account for more than 60% of total apps reviewed as shown in Figure 5, it can be reasonably assumed that the app price reported in the app store is not the true cost of apps incurred upon adoption. Therefore, the listed app price is not an influential factor in the enterprise mobility adoption decision.

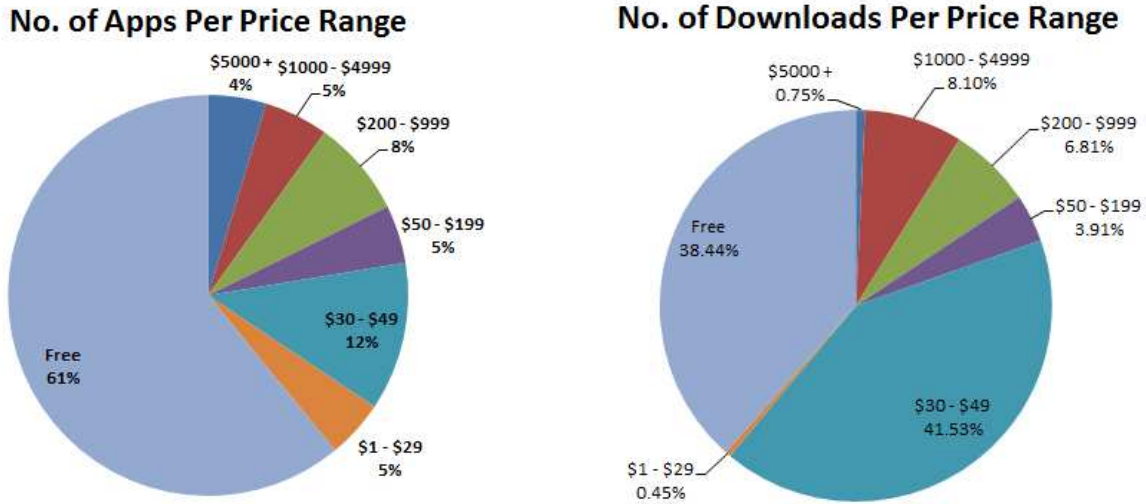


Figure 5. Number of Apps and Downloads per Price Ranges

To verify the research results, the researchers interviewed two enterprise mobility experts. Our observations were confirmed as described by one interviewee:

Traditional enterprise software is highly customized. To the point that it's really difficult to just say, here's a shrink-wrapped mobile product that can talk to your backend, because backend is so highly customized...everything becomes consulting.

All experts interviewed stated the fact that enterprise mobile apps are typically connected to the backend enterprise systems, so those apps need to be carefully designed and customized and the cost associated with adopting enterprise mobile apps should be much higher than adopting consumer mobile apps. However, such additional or hidden costs become part of consulting charges as in “everything becomes consulting.”

As from mobile vendor perspective, it is observed that about 60% of the mobile apps (123) are developed for customers free of charge with the growth rate at 9.01 apps per month (see Table 9). The growth rate of the priced apps is 5.81 per month. The minimum, average, and maximum prices for the apps available in each month are reported in the table. The prices are listed prices. The actual charge of each mobile app is subject to the size of a company, the number of apps the company purchases, as well as the negotiated terms of app usage.

| | 03-12 | 04-12 | 05-12 | 06-12 | 07-12 | 08-12 | 09-12 | 10-12 | 11-12 | 12-12 | 01-13 | G. Rate. | Total (%) |
|--------|--------|-------|-------|-------|-------|-------|-------|---------|--------|---------|--------|----------|--------------|
| Free | 28 | 1 | 11 | 6 | 7 | 9 | 5 | 1 | 6 | 44 | 5 | 9.01 | 123 (60.29%) |
| Priced | 22 | 1 | 5 | 1 | 1 | 6 | 2 | 10 | 10 | 17 | 6 | 5.81 | 81 (39.71%) |
| Min. | 38 | 300 | 38 | 29.99 | 790 | 30 | 75 | 19.99 | 4.99 | 3 | 24.99 | | |
| Avg. | 798.05 | 300 | 59 | 29.99 | 790 | 285 | 262.5 | 9301.20 | 285.45 | 1174.53 | 281.17 | | |
| Max. | 12000 | 300 | 75 | 29.99 | 790 | 600 | 450 | 24999 | 1500 | 4950 | 750 | | |

Table 9. Listed Price of Mobile Apps

While free mobile apps may receive their revenue indirectly from advertisements, revenues here are estimated directly through the number of downloads of priced mobile apps. For priced apps, the total average downloading number is 933.53 with a 36 monthly growth rate. The total revenue for priced apps is about 4.6 million dollars with monthly growth rate at 25 thousand dollars (see Table 10).

| Time/Month | 03-12 | 04-12 | 05-12 | 06-12 | 07-12 | 08-12 | 09-12 | 10-12 | 11-12 | 12-12 | 01-13 | G. Rate | Total |
|----------------|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|---------|
| # of downloads | | | | | | | | | | | | | |
| Min. | 93 | 209 | 44 | 63 | 4 | 5 | 20 | 0 | 0 | 0 | 0 | | |
| Avg. | 461.27 | 209 | 129.2 | 63 | 4 | 28.17 | 29 | 0.3 | 4.8 | 3.12 | 1.67 | 36 | 933.53 |
| Max. | 1382 | 209 | 313 | 63 | 4 | 49 | 38 | 3 | 26 | 12 | 4 | | |
| Total Revenues | 4294542 | 62700 | 39834 | 1889 | 3160 | 50280 | 18600 | 60 | 11306 | 92395 | 4034 | 25094 | 4578800 |

Table 10. Estimated Revenue of Priced Mobile Apps

ERP System Maturity in Enterprise Mobility Adoption

The results indicated no significant statistical evidence to support that ERP system maturity has impact on enterprise mobility adoption. One of possible explanations is that the business benefits drive the enterprise mobility adoption regardless of their ERP system maturity. To confirm our observation, we interviewed the founder of an enterprise mobility company that develops and markets mobile sales apps through SAP mobile app store. The founder indicated that enterprise mobile apps are very powerful ways to reengineer business processes and act as a changing agent to improve work behavior.

If you are looking at a lot of sales people, they have a tendency to always sell the same things to the customer over and over again. So they walk into the store and they say, you bought these things last week, you are going to buy the same things this week. So they create a process around “recently bought”, So this is their old habit. But the reality is, that doesn’t really help the company sell new products, it doesn’t help them sell profitable products. So what we did was to have one recommendation list that takes into account of everything, even though in their minds they were still thinking it was the same “recently bought” list, but we put some additional identifiers beside it. We put little notes beside it that said, oh, this is a “gold” product, this product is “out of stock”, this product is a “favorite”...So by changing user experience, we change the business process without the user feeling that the process has been changed, and they become more productive because of [mobile apps].

Additional studies to investigate business benefits and their impact on enterprise mobility could provide additional insights and would be invaluable.

Discussion and Conclusion

In this research, we combined quantitative as well as qualitative methods to investigate the emerging phenomenon of enterprise mobility, including its market structure, its pricing/cost model, its adoption trend, as well as its potential business benefits, through the lens of SAP mobile app store. We find that enterprise mobility is a fast growing market with broad impact that potentially affects many business areas across many industries. While its implementation may incur significant integration cost, the potential business benefits it brings are also tremendous, including business process efficiency, improved work productivity, direct cost reduction through employee self-service, and improved work experience and happier employees. It not only expands the reach of traditional ERP systems, but also revolutionizes how they are used in the enterprise.

We do acknowledge two limitations of this research. First, while SAP’s mobile app store could be a very useful lens to examine the mobility in the enterprise, it certainly does not capture the enterprise mobile market as a whole. In our future research, we intend to expand our study to investigate the enterprise mobile solutions in other ERP platforms, such as the ones offered by Oracle. Second, a part of the result is based on interviews with two enterprise mobile experts. We intend to interview more business professionals to capture a more complete picture of enterprise mobility.

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