When Technology Assets become Liabilities: Evolution of the Business Process Management Systems Market

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Abstract

Tracing market entries and exits, we present a longitudinal analysis of the marketplace for Business Process Management Systems and identify four successive phases of development that match the theory of industry life cycles: Introduction, Growth, Maturity, and Decline. Looking more closely at the transitions between these phases, we show that external technology developments can be seen as environmental shocks that signal the transition from one life cycle phase to the next. Our findings provide a novel mechanism for analysts to forecast possible technology market shifts.

Keywords: Market Life Cycle Theory, Technology Debt, Workflow Software, Business Process Management

1. Introduction

Business Process Management Systems (BPMS) represent a unique class of enterprise software that has significantly impacted organizational operations over the past four decades. Unlike traditional enterprise applications that focus on specific functional areas, BPMS serve as coordination platforms that orchestrate complex, cross-functional processes across departments, divisions, and entire organizations. From their inception as Office Automation prototypes (see, e.g., Morgan, 1976, Zisman, 1978), through the era of Workflow Management Systems (see, e.g., Abbott and Sarin, 1994) to today's intelligent Business Process Management Suites (see, e.g., Dunie et al., 2019), BPMS vendors have consistently promised - and often delivered - improved efficiency, consistency, and adaptability in organizational processes.

The evolution of the BPMS market itself presents an intriguing case study in technology adoption and market dynamics. As a long-lived yet evolving technology, BPMS offer a unique opportunity to examine how enterprise software markets develop over extended periods, navigate technological shifts, and respond to changing organizational needs. However, longitudinal studies in the area of Business Process Management are rare. Existing studies focus either on the evolution of research in this area (see, e.g., Bartlett et al., 2023 and Reijers, 2021) or the application of BPMS from the perspective of end-user organizations (see, e.g., Reijers et al., 2016). Our study addresses this gap by tracing the trajectory of the BPMS market over nearly half a century, drawing from primary and secondary sources to provides insights into the factors driving market phase transitions. By focusing on vendors and systems, we illustrate the evolution of commercially available BPMS technology, offering valuable lessons for both practitioners and researchers in the field of Information Systems. Moreover, this analysis may shed light on broader patterns in technology market evolution, contributing to our understanding of how enterprise software markets mature and adapt over time.

To understand the evolution of the BPMS market, it is important to recognize the core functionalities that define these systems. Architecturally, a typical BPMS consists of a common set of components (for more detailed descriptions see, e.g., Hollingsworth, 1995, Jablonski and Bussler, 1996, Leymann and Roller, 1997, Dumas et al., 2018):

- A design environment for process models, decision logic, and interface logic, such as forms or service calls.
- A repository to store these designs and deploy them to production.
- An engine that creates process instances based on

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the stored designs and coordinates their execution.

- A set of connectors that allows the engine to invoke external program logic (such as web services).
- A set of Application Programming Interfaces (APIs) that allows external clients to access the engine. These clients include task management interfaces for human process participants and reporting and dashboard applications for administrators and process managers.

While the detailed designs of these components have evolved over the years, their functions have remained relatively unchanged. It stands to reason that vendors that entered the BPMS market in its infancy could have an experience advantage over their competition based on the technology's maturity. Yet, many early BPMS vendors have disappeared, having either been acquired or gone out of business entirely. Conversely, new vendors have entered the market in later stages and captured significant market share. Additionally, the rise of open-source BPMS in recent years has put further pressure on incumbent commercial vendors. Finally, academic research in the BPMS space has resulted in numerous prototype systems, and a few of these, but not all, have influenced commercial products. We are interested in understanding the dynamics of this market evolution.

As BPMS can become integral components of an organization's work distribution infrastructure, they are often tightly integrated with other enterprise systems and thus difficult and costly to replace. To reduce the risk of incurring switching cost, a reasonable user would pay attention to the ability of a given vendor to support their product in the long run. In this sense, BPMS share traits with Enterprise Resource Planning systems and Business Rule Engines, which can become virtually inseparable from their surrounding systems and organizational processes. For instance, it took a large US insurance provider four years to replace an embedded business rules engine from their applications after the expiration of their license (see *Fair Isaac Corporation v. Federal Insurance Company*, 2019). The life expectancy of a system and its supporting vendor are therefore critical decision-making factors for technology executives.

The BPMS market is particularly compelling for studying technology market dynamics due to several factors: First, its nearly five-decade history allows observation of a full market lifecycle, from introduction to potential decline. Second, BPMS's critical role in organizational infrastructure creates unique market dynamics where vendor longevity significantly influences purchasing decisions. Third, the market exhibits paradoxical behavior, with early entrants not necessarily dominating and successful late entries occurring. Finally, its evolution has been shaped by both technological shifts and economic events, providing insights into how different external factors influence market dynamics over time.

We analyze the evolution of the BPMS market through the lens of evolving industry regimes. By observing entries of new systems and exits through discontinuation, merger, or acquisition, we develop a model of the BPMS market consisting of four phases: introduction, growth, maturity, and decline. We then investigate the phase transitions, in particular, the exogenous factors that contributed to changes in market dynamics. We find that traditional industry models seem to explain the market dynamics of the BPMS market well, and that technology changes seem to have an effect in early market phases, but that the latter phase transitions can be attributed to changes in the economic environment, rather than specific technology development. We pay particular attention to the latter, as contemporary technology developments in the form of Artificial Intelligence APIs have been cited as a disruptive factor for establish systems.

2. Background

The evolution of the BPMS marketplace can be observed through the lens of a life-cycle model, from inception to sunset for products, or founding through dissolution for firms. While information for systems are readily available through sources such as press releases, research papers, and vendor websites, information about firms or their customers is more difficult to obtain. First, many BPMS vendors were privately held and did not publish revenue information. Second, the addressable market for a given BPMS vendor is potentially vast, as the technology can be adopted across many industries. Most publicly available information about market share stems from the marketing materials of vendors, and should be viewed as anecdotal. In one salient example, a vendor claimed an installed base of 1.4 million seats for their product (Emery, 2003). The U.S. Department of Defense had signed an enterprise licensing agreement with the vendor, and the vendor used the total number of employees that might potentially access the platform as the basis for their adoption claim, while the number of concurrent users was significantly lower. Today, many process automation platforms are deployed using cloud-based infrastructure, and enterprise-wide licenses are common. To understand the extent of system use, metrics such as daily active users or monthly active users

provide more precise measurement points, but are rarely published. Determining the market share of any given solution is therefore a problem we leave to economists, and focus on the product level.

Life Cycle Stage	Characteristics
Introduction	**Market:** Low volume, high uncertainty and risks for early adopters **Product:** High degrees of innovation and variation **Firms:** Moderate entry rates of startups
Growth	**Market:** Rapid growth, increased competition **Product:** Increasing standardization; Competitive improvements **Firms:** Increasing competition, generalist firms enter, shakeout begins
Maturity	**Market:** Saturation; Stable market shares; Technology maturity creates entry barriers **Product:** Incremental innovation; Less differentiation **Firms:** Consolidation; Customer loyalty with established vendors
Decline	**Market:** Demand decreases, volume shrinks **Product:** Innovation stagnation **Firms:** Increased exits; Focus on niche markets

Table 1. Life Cycle Stages (derived from Porter, 1980b, Klepper, 1997, Karniouchina et al., 2013, Lamberg et al., 2018)

The central premise of the industry life-cycle model holds that industries traverse a series of stages - introduction, growth, maturity, and decline - delineated by turning points in the rate of sales growth. Industry growth tends to follow an S-shaped curve due to the processes of innovation and diffusion surrounding a new product (Porter, 1980b). Not all authors include all four life-cycle stages. For example, Hamilton, 1989, only considers the stages of growth, maturity, and decline, and does not consider the introduction phase separately. Due to the limited data on non-public firms, studies that rely on public industry data often start at the growth stage (Karniouchina et al., 2013). Because the inception of BPMS technology is well documented in the literature (see e.g. Morgan, 1976, Meyer, 1982, Abbott and Sarin, 1994), our data includes the development of prototypes in laboratories and universities. Some of these prototypes are stand-alone (e.g., Dourish et al., 1996), while others either build on previous generations of systems (e.g., Mahling et al., 1995), or leverage existing commercial infrastructure (e.g., Grefen and Hoffner, 1999). We therefore include the Introduction phase as the initial life cycle phase.

While industry life cycle phases may explain some differences in firm performance, Nelson, 1991, argued that not all firms in a given industry behave the same, even if their industry life cycle phase presents a stable environment. He suggests that differences at the firm level, or even the business unit level, are better predictors of firm performance. Given our data on the evolution of the BPMS industry, we investigate whether there are outliers among the BPMS vendors, whose behavior differs from what we would expect in a particular industry life cycle phase.

Table 1 lists the expected evolution of markets, firms, and their products in different phases of the industry life cycle.

Each stage of the life cycle exhibits distinctive characteristics related to the market, product, and firm dynamics (for a deeper discussion refer to (Kotler and Keller, 2009) and (Klepper, 1997). In the introductory phase, the number of new entrants to the market is high as both sellers and customers perceive the novel product and market as potentially lucrative. Being an early entrant can be advantageous yet also involves considerable risk and expense. High uncertainty defines business operations during this stage. Product innovation progresses rapidly and fundamentally as the market explores which product configurations might better satisfy customer preferences. Numerous new entrants join the fray, fueling competition. In markets for technology-based products where accelerating innovation cycles are vital due to shortening product lifespans, early market entry can confer benefits.

During the growth phase, the market witnesses a sharp upswing in sales as early adopters embrace the product and additional consumers start making purchases. New competitors enter, lured by the opportunities, attempting to introduce novel product features. However, as the industry evolves, technological diversity gives way to standardization, with certain design approaches gaining dominance and larger market share. By investing in product enhancements and promotion, a firm can secure a dominant position. In burgeoning markets, the number of participants peaks before a shakeout occurs. Prior to this, product lines proliferate, leaving buyers inundated with choices.

It merits mention that industry growth does not always conform to the S-shaped pattern. In some cases, industries bypass maturity, transitioning directly from growth to decline. Other industries may experience revitalized growth after a decline phase, while certain industries appear to skip the slow initial uptake of the introductory stage altogether (Porter, 1980a).

In the maturity phase, the rate of sales growth decelerates, and the product enters a period of relative stability. Both buyers and suppliers are well-acquainted with the products. Buyers understand what they

seek, and suppliers grasp market needs. Market shares solidify, changing gradually, and new entrants struggle to displace incumbents due to barriers like R&D costs, infrastructure requirements, or established branding. The ideal product configuration is known, and innovation slows to incremental refinements (Rogers, 1983). The rate of new entries into the market declines, and market shares stabilize. Established connections with customers and suppliers (including capital market access) act as buffers against major shifts in market share distribution.

Many products also experience a subsequent stage where they are supplanted by superior new offerings. In this decline phase, sales diminish for reasons like technological breakthroughs, evolving consumer preferences, and heightened domestic and foreign competition. As sales and profits erode, some firms exit the market. The industry consolidates around the few remaining competitors. Growth stagnates, intensifying rivalry and a shakeout, except for the most formidable players. Efforts at meaningful differentiation often falter, and survivors pursue scale economies, international expansion, and other efficiency or process-oriented competitive advantages (Karniouchina et al., 2013; Lamberg et al., 2018).

Building upon the foundational concepts discussed, we aim to understand what factors drive phase transitions within the market for Business Process Management Systems. Our research question is: What is the evolutionary shape of the Business Process Management System market? If the market adheres to the traditional industry life cycle phases, we further examine what might explain the timing of the phase transitions. This question is important, because the phase transitions can reveal underlying mechanisms that govern market dynamics, providing valuable insights into both historical and future industry behavior. To address these questions, we have compiled data on BPMS products over the past four decades. This dataset encompasses key events such as market entries, exits, mergers, and acquisitions. By analyzing these events, we aim to uncover determinants of industry shifts. Our research not only sheds light on the historical trajectories of the BPMS market but also offers strategic insights for firms navigating similar high-tech industries.

3. Data

Our dataset was collected at the product and firm level. We gathered archival information about the lifecycle of 130 different Business Process Management Systems and their predecessors, such as Workflow and Office Automation Systems. Our primary criterion for product inclusion was that the product had to exhibit the main architectural features of a BPMS as discussed in section 1. We included prototype systems created by universities and corporate research laboratories in our list of systems, as their existence was naturally well documented through publications (such as Shan et al., 1997, Abbott and Sarin, 1994, or Ellis, 1999). We consulted contemporaneous press releases, corporate filings, vendor brochures, and technology magazine articles from sources such as ComputerWeek and BusinessWeek. We also reviewed analyst reports such as Hill and Sinur, 2006. In some cases, we reached out to the architects and designers of the original systems to obtain background information on early system trajectories. In cases where a system offered BPMS functionality in the context of a larger application (e.g., an imaging system),

In total we identified 153 distinct systems. In some cases, these systems evolved over time and in the hands of different vendors. If the provenance of the system was well documented, we gave different iterations of the same system the same identifier. An example for this is IBM's FlowMark system, which was created in 1993, rebranded as MQSeries Workflow in 1998, further rebranded as WebSphere MQ Workflow in 2003, WebSphere Process Server in 2005 and Business Process Manager in 2011, when it was merged with IBM's Process Automation Lombardi Edition (which was Lombardi's Teamworks product, launched in 1999 and acquired by IBM in 2010). Another is FuegoBPM, which originated in 1999, was acquired and rebranded by BEA as AcquaLogic BPM in 2006, and further acquired and rebranded by Oracle to Oracle Business Process Manager in 2008. We would naturally expect that the code base of these systems changed over time, but that the architectural roots would still be the same.

We identified 156 unique entities that at one point or another owned one or more of the systems. Some vendors offer multiple BPMS products, either as a result of differentiated offerings (as in the different BPMS use cases supported by IBM), mergers with competitors (as in the acquisition of BEA by Oracle), or, in the case of companies like OpenText and Hyland, as the result of strategic portfolio rollups. We tracked known name changes for products that remained with the same vendor, but did not record separate name change events when a product was renamed due to an acquisition.

For each system we record the year of creation, years of known name changes (aka rebranding), years of ownership changes, and the year when the system was decommissioned or sunset. Of these events, sunset years were the most difficult to determine. Companies

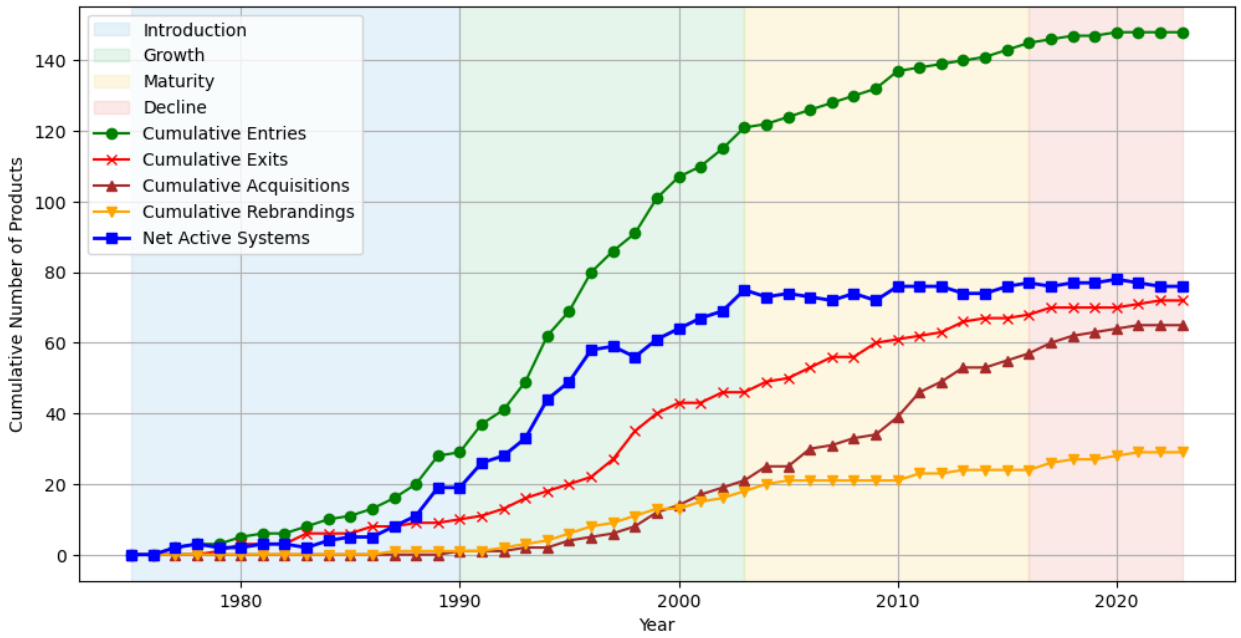

Figure 1. Cumulative Entries, Acquisitions, Rebrandings, and Exits 1975-2023

announce product releases and mergers and acquisitions publicly, but the end of the support lifecycle for a product is often just communicated to the existing customer base. Some large vendors (such as IBM and Oracle) have well documented support timelines, even after sales of a product ended. In these cases we recorded the published last year of vendor support. In other cases, companies went out of business, trademarks lapsed, or products were sunset by the new owners directly after the acquisition (typical for an acquisition where the target is the engineering staff, not the product itself).

In total our dataset contains 319 distinct events, 149 product launches, 32 rebrandings, 66 acquisitions, and 72 sunset events.

4. The Market for BPM Software

Figure 1 depicts the cumulative number of entries and exits in the BPMS market from 1975 to 2023, as well as acquisitions and renaming of products. We indicate the four phases of the Industry Life Cycle through different background shades. The phases identified here are based on the characteristics outlined in table 1, with the acknowledgment that these periods may not have rigid boundaries.

The graph of new system introductions closely follows the S-shape suggested by Porter, 1980a. Notably, the initial market phase is followed by a period of exponential growth that begins around 1990 and continues through 2000. Around the year 2003, the exponential growth in cumulative entries begins to taper off, marking an inflection point that coincides with the Maturity stage. In the second half of the 1990s we observe an increase in the number of exits that flattens out around the year 2000. During the following maturity phase, we notice an uptick in mergers and acquisitions, corresponding to the the theory of market consolidation. This trend continues through the late 2010s, but begins to flatten around 2013. Since the early 2000s, the number of BPMS products available has remained virtually unchanged, which could be interpreted as a signal for a coming decline.

Life Cycle	Years	Entries	Exits	Acq.	Reb.
Introduction	1977-1990	28	9	0	1
Growth	1990-2003	87	37	19	17
Maturity	2003-2016	28	21	36	8
Decline	2016-2023	6	5	11	6
Total	1977-2023	**149**	**72**	**66**	**32**

Table 2. System Entries, Exits, Acquisitions, Donations, and Rebrandings

Table 2 sheds light on the evolution of the BPMS market through the lens of the Industrial Life Cycle Theory, offering a more granular view of the market's evolution by breaking down the entries, exits, mergers and acquisitions, and other events that transpired within the market by life cycle stage. BPMSs are often long-term investments, and the stability of vendors is

crucial for customers who seek to minimize the risk of disruption. Understanding market dynamics along with the impact of technological advancements can provide valuable insights into vendor reliability and future market trends. In the following sections, we examine the individual life cycle stages more closely.

4.1. 1977-1990: First Prototypes and Commercialization

During its early years, the BPMS market exhibited a slow but steady increase in new firms and systems, leading to the introduction of 28 new systems. The systems of the late 1970s were largely research prototypes under the umbrella of Office Automation Software, led by Michael Zisman's work on SCOOP at Wharton, and the work of Clarence Ellis and Gary Nutt at Xerox Parc. It was not until the mid-1980s that the first commercial offerings arrived in form of Action Technologies (a Stanford spinoff) and Staffware (a UK-based vendor). While the promise of Office Automation had been discussed in the literature decades earlier (see e.g. Riche and Alli, 1960), the practical problems of distributing work required that certain fundamental technical issues had to be solved, namely networking and client integration. The introduction of the PC in the early 1980s gave vendors an opportunity to innovate, and the resulting systems showed a broad variety of approaches to process specification, client integration, and technical novelty. While Action Technologies relied on a speech-act-based approach to specifying worker interactions, Staffware used a network approach (which later became the dominant paradigm to describe processes). As the technology had been largely untested outside of laboratories, early clients became the first industrial litmus test for the adoption of the technology, revealing strengths and weaknesses for the vendors to recognize. Prototypes and experimental systems were often abandoned after they had served their early purpose, and of the 28 systems introduced, 9 had already been sunset by the late 1980s.

4.2. 1990-2003: The Cambrian Explosion of Systems

As the market progressed into the Growth stage, the number of new entrants increased significantly from year to year, reaching 87 over the next 13 years. We can attribute this growth to three major factors.

First, the first successful commercial deployments of BPMS (or workflow systems, as they were called then) assured companies that had been sitting out the introductory phase, that the technology was viable for vendors as well as for clients. Following the notion of Moore's Crossing the Chasm model (Moore, 1996), the market had moved from enthusiasts to early adopters, and would soon reach the early majority.

Second, the emergence of World Wide Web technology as a mechanism to design client interfaces upended the Client/Server model that had become the basis for many systems designed in the 1980s. Firms that had a proprietary technology advantage on the basis of their system architecture now faced the prospect of a significant technical debt (Rinta-Kahila et al., 2023). These firms now had a dual mandate: Serve the existing clients that had been early adopters, and redesign their systems to take advantage of the emerging web infrastructure. Smaller firms with fewer engineering resources had a harder time with this transition, and were displaced by new startups that could design their systems "Web-ready". Larger firms, such as IBM, Siemens Nixdorf, and Hewlett Packard entered the market, but their size did not protect them from strategic mistakes. For instance, IBM's FlowMark product was offered in a (successful) mainframe version, while the solution for smaller clients was based on the unsuccessful OS/2 operating system.

Third, funding for new ventures became increasingly available during the 1990s, both for research prototypes through funding programs such as ESPRIT and the NSF, as well as venture capital funding for new startups (particularly in the latter part of the decade). This influx of capital accelerated the rate of system entries, and of the 87 new systems (plus the 19 survivors of the previous decade), only 37 would not exist by the year 2003.

4.3. 2003-2016: Consolidation and Stability

Beginning in 2003, the entry rate for new systems reduced sharply, but so did the exit rate, which is somewhat surprising. Closer inspection of this period shows that the mode of competition shifted from survival to consolidation. Whereas in the previous 13-year phase 19 systems changed hands between vendors, in the ensuing 13 years there would be 36 acquisitions as opposed to 28 new system entries and 21 system sunsets. The acquisition activities during this time fall into 3 categories.

First, some vendors acquired competitors to gain access to their engineering staff (acqui-hires) or the underlying base technology (but not the marketable product). When specialized skills or technologies are not available on the open market, acquiring a company made up of such specialists and intellectual property may present a viable option for a firm. An example of such a transaction is the acquisition of Polymita by RedHat, where the BPM product developed by Polymita

was almost immediately sunset, but the underlying technology was integrated into RedHat's product stack.

Second, some vendors pursue a "roll-up" approach, where they acquire an established brand and product to gain access to their customers. They continue to maintain and service the acquired product, in return for a stable revenue stream of maintenance fees. A prominent example of such a roll-up is the company eiStream (later Global360), which acquired BPMS products from ViewStar, Eastman, and others, and maintained the different products for the existing customer base. In 2011, Global360 was acquired by another company known for its roll-up approach, OpenText. In addition to Global360 and many other technology providers, OpenText also acquired Cordys, a dutch BPMS firm.

Third, some vendors see integration potential of a stand-alone product into their technology, and acquire the BPMS vendor as the missing link in their technology strategy. An examples for such an acquisitions is the purchase of Lombardi Software by IBM. Lombardi offered two products - Teamworks, which directly competed with IBM's BPMS offerings, and Blueworks, a lightweight process design tool that filled a gap in IBM's offering. Soon after the acquisition IBM sunset Teamworks, but continues to market Blueworks as an IBM product.

Reviewing figure 1, there is a marked increase in acquisitions during the period of 2009-2012. This coincides with the timing of the global financial crisis, during which venture financing was hard to come by, and potential customers were delaying investments in their technology infrastructure. For companies that had the financial means, there was an opportunity to buy into BPMS technology at a discount. However, this explanation begs the question: Why didn't we observe a similar bump during the dot-com crisis of 2000? One conjecture is that while the number of products in the market had grown rapidly in the 1990s, the commercial adoption of BPMS was just beginning to catch up during this period, so acquiring a vendor to gain access to the customer base was much more attractive around 2010 as opposed to 2000. A second conjecture has a more technical basis.

BPMS have many integration points with existing applications (to marshal data, notify participants etc.), hence their connectivity with outside systems is a defining feature. In the late 1990s, there were two camps of integration-oriented BPMS: Java-based systems, which relied on Java 2 Enterprise Edition servers (J2EE), and .NET-based systems, which were specifically designed for Microsoft's infrastructure offerings. In the early 2000s, service-oriented computing using XML messages over HTTP began to dominate as the architectural paradigm for systems integration. Similar to the transition from Client/Server systems to web-based clients, BPMS vendors that had built their integration services on the basis of CORBA, J2EE, or .NET were facing a situation where their technology assets had turned into technology debt and needed to be reengineered. This took time, while several new products following the emerging standards launched in the early 2000s. Consequently, by 2010 there were more attractive acquisition targets than in 2000.

Finally, the emergence of open source BPMS stands out during this period. Making source code publicly available and modifiable can serve multiple purposes, such as a broader developer base and encouraging a wider adoption in public. Successful open source platforms such as the Linux operating system or the Apache web server are widely used. Sungard and Intalio both donated their BPMS to the Eclipse open source foundation, but neither project saw much success. We counted 11 new open source BPMS during this period (compared to 4 in the previous 13 years), however, 9 of these efforts were abandoned by the end of the period. The first open source BPMS that saw widespread adoption was jBPM (2003), which is still being developed today. While the original architect of jBPM has long moved on to other projects (Alfresco Activiti and Effektif), the maintenance of the jBPM project is now overseen by RedHat and IBM. Incidentally, the Activiti open source BPMS became the starting point for two very successful open source BPMS, Camunda and Flowable, which are increasingly used in place of commercial products.

4.4. 2016-2023: Start of the Decline?

The final period hints at a potential decline in the BPMS market. With only six new entrants, the data suggests a decrease in market dynamics. This could indicate a saturation point where the market has reached a level of maturity with established players dominating the landscape. As the open source offerings become more reliable, firms are reconsidering their investment strategy in infrastructure technology. Long-term participants in the market have found niches (government systems, vertical industries, scientific workflows), and technical innovation in the BPMS field comes less from the core BPMS product, but increasingly from ancillary offerings such as Decision Automation, Process Mining, and - possibly - the integration of generative Artificial Intelligence features.

As a market, the BPMS market seems to be of limited interest for new entrants. All vendors are

faced with a mature foundational technology stack, where many of the baseline components come from established open source efforts (such as messaging, database technologies, and integration protocols). At the same time, we do not observe a significant increase in market exits, either. Acquisitions have been moderate in the past 8 years, and only 5 systems have been sunset. It appears that current vendors have carved out sustainable positions in the market, either through an existing customer base, or through focus on specialized niches. This mirrors very closely what we would expect during the decline phase of an industry.

Opportunities for differentiation exist mostly in the added-value features. Examples of these features are Process Mining, Robotic Process Automation, and Decision Automation.

Process mining describes the generation of process information from audit trail information, a data byproduct of information processing. During the early 2000s, Process Mining was a largely academic effort, that gained maturity around 2011. Specialized process mining vendors such as Celonis and Apromore have received significant valuations from their venture capital backers, while others have been acquired by established technology firms, such as Microsoft's acquisition of Minit. Several BPMS vendors have added process mining functionality to their product offering.

Robotic Process Automation is a technology designed to automate process steps that rely on applications that are not easily to integrate at the infrastructure level. These steps may include the capture of information from scanned documents and entry into web forms, or the integration of mainframe and office applications. Robotic Process Automation vendors such as BluePrism, Automation Anywhere, and UIPath began to emerge in the 2010s and have established a significant commercial footprint in a number of industries. While theoretically complementary to traditional BPMS, these vendors are in a position where they might disrupt the established BPMS market from the inside out, by adding process orchestration features to their original products.

Decision Automation is a technology that allows organizations to codify business rules in an execution environment that allows for the consistent and fast evaluation of rules, while preserving the ability to modify rules in an agile fashion. Decision Automation technology has its roots in Business Rules Management Systems that were first introduced in the 1980s. In 2015 the Object Management Group standards body released a notation for decisions (Decision Model & Notation), that makes the design of rule-based logic more end-user friendly compared to prior proprietary approaches, and provides for a simplified integration of rules with business processes through an integration with the dominant notation for process models, BPMN.

5. Conclusions and Outlook

The BPMS market has undergone substantial evolution influenced by various external technological advancements and market events. Our data shows that the evolution of the BPMS market follows a predicted S-shape. It also shows that the timing of the transitions between the life cycle phases can be explained through exogeneous events, both technical and economical.

During the introduction phase, several foundational technologies laid the groundwork for the development of the BPMS market. The integration of Ethernet into office work enabled basic connectivity, facilitating the first steps towards the automation of office tasks (van der Aalst and van Hee, 2002). Xerox introduced in the mid-1970s early products using Ethernet (Haigh, 2006). Along with the development of Database Management Systems and Local Area Networks these foundational technologies provided the necessary infrastructure for storing and sharing information within organizations. The advent of email systems changed the way offices communicated, but the different email standards made seamless communication a challenge. It is not surprising that the name of one of the earlier workflow systems was "BeyondMail".

The growth phase was marked by significant technological advancements and market expansion. The introduction of the TCP/IP Protocol and the widespread adoption of Personal Computers facilitated the development of more sophisticated and scalable BPM solutions. The advent of Client-Server Architecture in the mid-1980s allowed for more robust and distributed BPMS, which could handle more complex processes and larger volumes of data, but the same technology became a liability for the early market entrants once web-based applications emerged. The growth period saw a surge in market entrants driven by these technological innovations. For example, companies like Lotus Development Corporation introduced Lotus Notes in 1989, a client-server collaborative application that significantly advanced BPM capabilities. The introduction of Netscape Navigator in 1994, one of the first web browsers, made it easier for businesses to adopt internet-based BPM solutions. Little known today, Netscape offered a BPMS during its most successful days that it co-developed with SUN microsystems.

The maturity phase of the BPMS market was characterized by market consolidation and the dominance of established players. The emergence

of Software as a Service (SaaS) and Cloud Computing during this period revolutionized the delivery and scalability of BPMS. SaaS allowed organizations to adopt BPM solutions without the need for significant on-premise infrastructure investments, providing flexibility and cost-effectiveness. Service-Oriented Architecture (SOA) enabled seamless integration with other enterprise systems, enhancing the appeal of BPMS. The introduction of Web 2.0 technologies facilitated more interactive and user-friendly applications, helping the adoption of BPMS. The growth of open-source BPMS during this period introduced competitive pressure, challenging incumbent vendors to innovate and improve their offerings. Examples like the adoption of open-source solutions such as Bonita BPM highlighted the shift towards more cost-effective and customizable BPM options.

The emerging decline phase of the BPMS market is marked by a reduction in new market entrants, indicating market saturation. While we would have expected to see an increase in market exits, this has not yet held true. However, the emergence of transformative technologies such as generative Artificial Intelligence might offer the potential for market renewal. These technologies promise advanced capabilities for automation, data analysis, and intelligent decision-making. Companies like Camunda, Salesforce and UiPath have begun to integrate AI and Machine Learning into their BPMS, providing predictive analytics and more efficient process optimization, showcasing the potential for renewed market growth.

Our study of the evolutionary development of the market for Business Process Management Systems is designed to be both retrospective and forward looking. While some studies exist that summarize the early years of the BPMS market (e.g., Abbott and Sarin, 1994; Ellis, 1999; Georgakopoulos et al., 1995; Shan et al., 1997), few studies have looked at the overall evolution of products and vendors over the past 25 years. Our unique dataset, covering almost 50 years of office automation, workflow, and BPM technology is a first step toward understanding the dynamics of this important market.

Our study is not without limitations. As noted earlier, identifying the exit date for a particular solution has proven challenging, and could skew our data related to the number of overall market participants. The universe of BPMS covers products developed by dedicated vendors (pure-play offerings), but also engines that are embedded in larger applications (e.g., SAP Business Workflow or Salesforce Process Builder). Since these products cannot be procured without the surrounding system, we have excluded them from our data set. To understand the evolution of the BPMS market, others may feel that including these systems may be warranted.

While our current analysis focuses on products and firms, we feel that the constituent functional components of the BPMS included here may warrant additional research. Our discussion of the evolution of BPMS was guided by the relevance to the lifecycle phase model we use in this paper. But firms perform differently, even in the same market phase, and a deeper analysis of the functional components may shed some light on the sophistication of the current crop of BPMS offerings.

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