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Integration of Information Systems: Robotic Process Automation

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Abstract

This paper offers an overview of Robotic Process Automation (RPA). It approaches this technology from the perspective of systems integration, and the presently suggested value of Robotic Process Automation (RPA) in addressing information systems integration issues. The background requirements for organization process integration are discussed, and the methods organizations employ to achieve system integration are reviewed. RPA is described and its application and suggested benefits are summarized. The current literature indicates that RPA technology has been focuses primarily on the transactional processes that occurs between routinized and repetitive business processes and back office work that are performed by different information systems or manual follow-on processes. The future of RPA has been hypothesized to include bots that learn and implement analytical processes, and complex work steps requiring more reasoning. Significant research is needed to understand the benefits of RPA, and its growing popularity in organizations.

Keywords: Integration, Automation, Robotic, Processes, Value Chain Integration.

1. INTRODUCTION

This paper discusses a relatively new technology (Robotic Process Automation) that appears to be an innovations solution for addressing some of the critical organizational and business problems that require systems integration or manual support after systems processes are completed. This technology may be applied both within and among organizations. The RPA technology appears (inductively) to address a significant problem fort many organizations – integrating information systems work processes.

Integration has long been a critical concern for organizations. March and Simon (1958:195) defined the level of integration as "…lowest level at which all activates relating to a particular goal can be coordinated…" Thompson (1967:40 - 41) described integration (coordination of successive stages of production occurring in variety of fields) as rational behaviors designed to reduce crucial contingencies. The evolution of the integration concept is expanded below.

Integration has also been a significant factor in the development and implementation of information systems. Brancheau and Wetherbe (1987) described integration as one of the top ten issues in information systems management in both 1984 and 1987. Hasselbring (2000) discussed the importance and difficulties with integrating heterogeneous information systems to legacy systems, and inter-organizational processes that utilize information systems are highly autonomous. It is noted that this makes the integration process an even more challenging task.

Hasselbring (2000) explains that there are both external and internal drivers for integration. The external difficulties associated with system can be traced to the value chains that extend beyond organizational borders. This occurs because external supplier and customer information systems become linked as critical parts of each other's data and information architectures. From an internal perspective, organization units contain data in many application areas supported by a wide variety of workstation level tools, database, and collection tools that seek to share data among desperate, and organizationally autonomous information systems.

Exchanging data among these differentiated systems and the organizational units they support and passing essential data to other units to complete work processes is often complex, time consuming, and very costly. Information systems that are separated by departmental or other formal organizational decision making lines with distinct process and different but equally important business purposes are difficult to combine. The integration situation is alarming as organizations grow, combine, develop new products and services and the amount of work increases. Possible exacerbating circumstances include budgets decreases, and the unit processes morphing to involve more steps and procedures to ensure quality and accuracy. Greater labor costs, longer unit processes, increased governance, and pressures for high accuracy create a recipe for a disastrous planning, budgeting, and management brew.

There are other proposed method for addressing this concern. For example, Simon, Karapetrovic, and Casadesús (2012) developed and proposed a model to address the difficulties and recognize the benefits of standardized management systems. They assessed the level of integration of different MS elements such as the resources, documentation, goals and procedures. They conclude that managers and practitioners become aware of the challenges and obstacles of systems integration, and address them early in the process so they do not delay the completion of the integration process.

Integration demanded by organizations requires extensive coordination of shared resources and dependencies among activities in and across systems. A variety of information systems technical and functional solutions to this problem have been developed over the past 30 years. Since about 2010 a relatively new technology (Robotic process Automation (RPA) has become a major factor in improving systems integration.

This paper describes the integration problem, various enacted solutions and their limitations, and the status of the RPA technology available today. Form a research perspective, the work done on RPA is somewhat limited and focuses on case studies. Key question such as – when is the RPA technology appropriate, what criteria should be considered before adoption and implementation of the technology, and what are the limitations have not been explored well. This paper seeks to provide a discussion of the issues regarding the technology, and suggest why researching and developing a comprehensive understanding of RPA technology is important.

The popular literature and case studies indicate selection of this technology (over other approaches) seems to be based on assessment of the criteria driving the integration effort. These criteria are summarized and offered as a set of heuristics for the use of this new technology at the end of this paper.

Integration Background

Difficulties with the integration of business process has plagued organizations for many years. Information systems have been "inserted" into this essential mission of attempting to manage processes and their data, and improve the coordination and integration of the work within and between organizations.

The linkages between information systems and the integration mission can be traced back to Porter and Millar's (1985). They discussed the (then coming) role that information technology plays in the value chain and competitive advantages sought by organizations. They state that information technology must be viewed as encompassing information that businesses create as well as the many linked technologies that process the information. Their seminal work identified many examples of value creating activity that manages and uses information in work processes. They discussed the advantage that is derived from the information-processing component that execute steps required to capture, manipulate, and channel the data necessary to perform the value chain activity. The data handling improvements they identify (that could lead to competitive advantages from improved data handling) were extensive. They attribute potential improvements to: bar codes for error handling reductions, databases for knowledge and experience storage, management of services with data, improved weather satellite data uses, financial analysis through data, transfer of data between suppliers and manufacturers, data for improved designs for manufacturing coordination, uses of office support data, and communication data. It is important to note that their examples relate to the integration effects of these many data sharing and transmission opportunities.

Many other researchers have used the value chain framework to address the role of information systems in achieving helpful integration. For example, White and Person (2001) utilized Porter's value system concepts as the framework for integrating a firm's activities within the supply chain. They emphasized the importance of integrating customer service activities into the decision making process of manufacturing organizations. They further argue that just-in-time systems and new technologies (product, process and information) provide the mechanisms for integration of the various activities across the supply chain. However, they do not specifically show how this "integration" can be achieved using information technology (with low costs) across the value chain.

And there's the rub. Integration is costly and difficult to maintain. This paper will provide an overview of the methods used to achieve integration. But first, it will set the stage for the RPA technology by providing an overview of what it is, and why it is (apparently) being introduced into organizational processes as an integration tool.

Robotic Process Automation (RPA) and Processes

There are two underlying concepts important in Robotic Process Automation (RPA). One must be able to identify and understanding work "processes", and be able model the work processes. Conceptually, simple processes are groups of actions, steps, operations, and decisions or other related activities taken to achieve some goal or purpose. Process thinking is "viewing actions as groups of activities" with a purpose, not just seeing each step in isolation. This process concept is important for effective management, as Porter and Millar noted. It has been an important part of organizational quality management, performance improvement, and productivity enhancement steps for almost three decades. Process thinking requires systematic assessments of work actions and steps, concentrating on work that meets a customer's needs, targeting an objective or goal, focusing on value-adding steps and activities, utilizing user feedback in developing (improving) the process and always keeping in mind the end result – increased productivity.

RPA is software, in its simplest form - a bot. It is a specialize type of software (or code) that maps data from one layers of code to another layer. It may be viewed from a higher-level systems perspective as a connection subsystems from a layer architecture. The translation of data from one layer of code in a computer to another layer enables everyone to understand what the data are. RPA is a software "presentation" layer that is programed to find, access (read), and then re-enter correct data into a different specific location in a file or record. It also provides a way to view or display the data. Robotic process automation operates within this "presentation" layer of software. RPA is not an invasive technology that requires changes in a system or application. What this means is that applying this technology does not require that one change the existing process steps, calculations, comparisons, or actions. Thus, an organization can maintain its currently operating applications without massive modifications while improving performance.

Finally, RPA may also add capability to a current process. Thus, a new information system or a complex technical solution is not necessary when the RPA layer is used to access and perhaps enhance or modify the use of the data so it meets a new requirement (new report, further validation, incorporation into a different process, or a new test or comparison).

The bottom line is that the functionality in the presentation-layer automation software (RPA) is specific and matches the rules and steps in the operational work processes and flows. This rules-based action approach is not subjective. It automates (though a bot) a wide variety of back-office tasks from data entry, comparisons, and validation to automated ordering and payments.

2. PREVIOUS APPROACHES TO THE INTEGRATION PROBLEM

A number of major approaches to integration have been offered for organizations. The approaches have great value, but also bring limitations and costs before they can be used.

Same Data Solution

Information systems have called for organizations to normalize and simply "use the same data" for many years. This paper will not attempt to address the many reasons that this has proven to be an elusive objective. Information systems meet different functionalities, large organization develop specific terms and uses for the same data, and the enormous coordination and communication efforts required to achieve this elusive target are simply not "free."

Application Level Solutions
It has been recommended that organizations attempt to design and build information systems and applications in parallel. This is a form of managing the coexistence and coordination of multiple concurrent activities. The communication among the system components and their synchronization are common problems that occur when this is attempted. Coordination language is used to synchronize the activity of those computations through component cooperation. (Hasselbring, 2000).

Example systems using this integration approach include inter-organizational systems designed to enhance supply-chain visibility. The systems improve coordination between buyers and suppliers through electronic integration. (Grover, & Saeed, 2007). This tightens linkages in the supply chain, but data do not indicate how the conditions under which transaction exchanges are conducted impact the use of integrated systems. These transactional characteristics are important antecedents to integration under conditions where demand uncertainty, complexity, market fragmentation, and market volatility capture key characteristics that make integration important and very valuable. Data collected from the electronics industry show that firms tend to deploy integrated systems when complexity of the component is high, market fragmentation is low, and an open information-sharing environment exists. Thus, from a managerial perspective, integration is the appropriate configuration under conditions of high product complexity and open information-sharing environment, but it precludes the firm from participating in the open market and gaining brokerage benefits. (Grover, & Saeed, 2007).

Enterprise Solutions
At the enterprise level, a diversity of information systems is often employed for integration such as custom applications, e-business solutions and Enterprise Resource Planning (ERP). The solutions all support the organizational and financial business processes, but the diverse and incompatible systems restrict the automation of business processes and create a proliferation of integration difficulties. Organizations have used integration software called Application Integration (AI) to deliver flexible and more manageable Information Systems (IS) and infrastructures. The Application integration is achieved by linking functionality from disparate systems with adapters and message brokers. The case study of a multinational petroleum company that adopted this solution required up to 60% of overall project time to integrate the systems due to the necessary re-engineering of business processes by phasing out systems and reducing redundancy in functionality. (Themistocleous & Irani, 2002). Further work by Irani, Themistocleous, and Love. (2003) and Themistocleous, Irani, and Kuljis (2004) concludes that the capabilities of Enterprise Application Integration (EAI) technologies can support a direct shift away from disparate systems operating in parallel toward a more common shared architecture. They viewed this opportunity as a possible emerging paradigm shift since integration of IS is in-line with the needs of a business altering its IS life cycle. This makes evaluating the full impact of the system difficult, as it has no definitive start and/or end. This case study of IS applications within an e-Government framework can be viewed as a portfolio of technologies to improves infrastructure integration.

The organization level approaches which developed by 2000 sought to identify and integrate independent functions and productive resources across an organization through resource planning and optimization. Approaches involved sending emails and message with data at the lowest levels, and the establishment of common datasets and sources. Examples include SAP which implements organizational integration with a single database, and utilized messaging services for integrating autonomous ERP systems (Hasselbring (2000). Systems using this approach included TSI Software's Mercator which offered specialized functionality in pre-built application adapters to move data for data conversions and messaging services between the SAP R/3 and PeopleSoft ERP systems.

This solution often required reengineering the organization functional business processes to align with the ERP system. However, organizational componentization continued to support the business processes implemented through existing legacy systems.

Architectural Solutions
In order to solve the poor information sharing capability and business adaptability, by integrating logistics information system based on Service-Oriented Architecture (SOA), a fast and flexible integration method for enterprise information system was presented. The analysis and experiments show that it effectively reduced

the cost of system adjustments, shortened the adjustment time, and improved the efficiency of execution and the quality of adjustment, so that the market competitiveness of enterprise improved. (Wang & Wang, 2010)

General Solutions
Ball, Ma, Raschid, & Zhao (2002) discuss the need for supply chain integration (SCI) methodologies as being driven by increases in the globalization of production and sales. They offer an integration architecture, describe the software components of a prototype implementation, and discuss a variety of information sharing methodologies. Their framework of a multi-echelon supply chain process model spans multiple organizations, and promotes intra-organizational knowledge sharing.

The Ball, et. al. (2002) integration is required because the supply chain prototype consists of six main components including ERP, SCM, a simulation, middleware, collaboration software and visualization and decision tools. The ERP component contains multiple ERP instantiations for individual supply chain members. The SCM component integrates with the ERP instantiations to support planning and execution across the total supply chain. They note that the integration of the SCM component and the ERP components forms the integrated Supply Chain Infrastructure (SCI) architecture. The middleware component uses an integration manager, a message broker, data adaptors and a variety of APIs for communication.

3. THE FUNCTIONAL BREADTH OF THE INTEGRATION PROBLEM

A variety of modeling tools have been used to examine the problem and number of functional area examples are provided. The modelling approaches are illustrated by three widely used modelling methods: IDEF0 which is used to establish functional models, IDEF3 which captures process descriptions, and DFDs that describe data-flows among the functional activities. (Shen, Wall, Zaremba, Chen, & Browne, 2004). These tools illustrate the approaches different modelling methods follow at varying levels of granularity, and they types of information required to complete the models. Shen, et.al, 2004) propose that a set of business process models be combined to capture the advantages of each modelling method and maximize the effect of the distinct modelling efforts. They illustrate the effectiveness of this modelling framework in designing an order using a combination of the target enterprise's legacy systems and a catalogue the tools to facilitate the exchange of information (e.g. order request, estimated ship dates, credit checking, etc.) between the customer and the target enterpriser using fax or email or through another communications tool.

Control, Accounting and Reporting
There is a complex relationship between information system integration approaches, such as Enterprise Resource Planning, and management control. Chapman and Kihn (2009) analyze information system integration data architecture. They posit that the single database concept and the variety of ways in which information might be utilized in practice means that a centralized database will link to (positive) business unit performance. They contend that system integration fosters the four design characteristics that provide an environment where management control will be effective and positively related to perceived system success and business unit performance (based upon PLS analysis of survey data). Their conceptualization is that flexibility, innovation, discovery and testing of assumptions foster an ability to drill down into detailed data below the summarized data provided at higher levels.

Healthcare
Nyella and Mndeme (2010) describe the goal and process of restructuring the Health Information Systems (HIS) in dev eloping countries by standardizing and integrating various vertical reporting systems. The pressure resulting from the vertical nature and support for the systems rendered the integration goal challenging and unachievable.

Zapletal, Rodon, Grabar, & Degoulet (2010) examined how clinical data warehouses (CDW - subject oriented, integrated, time-variant, non-volatile collections of data used in support of management decisions) integration with clinical information systems (CIS – containing data for biomedical research) to provide functionality that is not easy to implement with traditional operational database systems. They examined the technology, data, restitution, and administrative functions of this rare integration effort. UML use cases and the mapping rules from the shared integrated electronic health records were matched. Clinicians and investigators were able to conduct clinical research, quality evaluations and outcome studies because of the integration. These indirect benefits support the continuous use of an integrated system. Value is readily demonstrated with new clinical data from tissue bank systems and biomedical research data that are integrated with legacy data sources. (Zapletal, Rodon, Grabar, & Degoulet, 2010)

Building Information Modeling
Building Information Modeling (BIM) seeks to utilize a digital representation of a facility's physical and functional characters with information in three dimensions (3D) to meet the needs of Architecture, Engineering, Construction and Facilities Management (AEC/FM) functions required to construct a highly usable facility.

Building Information Modeling (BIM) and Geographic Information System (GIS) is a promising and highly challenging topic to transform information towards the generation of knowledge and intelligence that can be utilized in the civil, building and infrastructure sectors. However, the original different purposes of the technologies have introduced significant challenges for the integration. The development and dissimilarities of various GIS and BIM applications show that integration approaches are developed for targeted reasons and focus on solving different specific problems. The parameters influencing the choice of approaches are "EEEF" criteria: effectiveness, extensibility, effort, and flexibility. Semantic web technologies provide a promising and generalized integration solution that comes with large efforts required at an early stage and the isolated development of ontologies within one particular domain. Openness is suggested as a key of the success of BIM and GIS integration. (Liu, X., Wang, Wright, Cheng, Li, & Liu, R., 2017)

Vehicles
Sch6ner, and Dose (1992) in early research on autonomous vehicles examined an approach to task-level system integration used to plan and control autonomous vehicle motion. They demonstrate the system capabilities and its ability to integrate redundant as well as complementary information with software simulations. They concluded that autonomous systems fulfilling tasks such as moving towards a goal and avoiding sensed obstacles face many problems because they must coordinate sensory and effector modules. They note that system integration is possible in the sense that all information provided by the various sensory modules and all information required by the various effector modules becomes part of the planning dynamics. Dynamic processes must then separate convergent information, and integrate actions by selecting a representative, from non-redundant information, which is kept invariant.

4. ROBOTIC PROCESS AUTOMATION

RPA is semi-automation and automation, effectively applied to rule-based, routine, and predictable tasks in combination with structured, understood, and stable data. (Primer, 2015).

Productivity and Performance
Employee productivity improvements are a byproduct of processes that are assigned to software robots. The software robot can process (without errors) the repetitive and more tedious jobs. It does not lose its place, slow down, skip an action, or forget. Fewer errors need to be identified, diagnosed, and assigned for to "rework." Fewer correcting adjustments are made to the outputs of the competed and standardized work. This provides time for the employees to concentrate on the exceptions or more difficult projects requiring a higher level of skill and training. These are the higher value-added activities that require more in-depth analysis, recognition of the exception, and personal interaction or problem solving decisions. This work adds value to a department or office and may be worth more, thereby increasing productivity. [It is also possible that this work will improve morale, and enhance employee retention.] (Asatiani, & Penttinen, 2016; Fung, 2014; Geyer-Klingeberg, Nakladal, Baldauf, & Veit, 2018, September).

The expanded capability and time available to the employee may also support the organization because these factors contributes to the overall customer experience by solving the customer's problem sooner. Employees will have more time to devote to the customer-facing roles. They are then able to analyze situations requiring personal involvement and direct communication thereby improving customer satisfaction. (Jovanović, Đurić, & Šibalija, 2018; Lacity, & Willcocks, 2015)

It must be emphasized that RPA reduces or possibly eliminates errors, especially those that are made by humans who process data, transpose numbers, or perform actions out of a required sequence. The most typical errors not made by bots are those common mistakes of transcription (error in copying) and transposition when information is input in the wrong order because people simply make errors when they type numbers rather than words. This accuracy improvement is real and measurable. RPA improves accuracy. Employees might make

mistakes, but software robots will not make those mistakes. RPA will also minimize or eliminate complications with employee errors attributed to training omissions, someone filling in (when the regular employee is out), cultural and language barriers, and errors attributed to processing that must occasionally occur in different locations or across time zones.
(Peláez & Kyriakou, 2008; Primer, (2015).

Application of RPA

The scope of the RPA technology is very impressive, and robust. It can be applied across many functions and seems practical for many different process focused tasks (definable, repeatable and rules-based). It can be executed at the direction of employees and assist them in their work by helping diagnose when decisions are not always clear (the data don't legitimately fit) and the rules base is not complete for all situations. RPA has multiple operating modes. It can operate in attended mode where an employee "triggers" the bot for day-to-day operations. The bot can function in an "unattended mode" on a server based on user-determined triggers such as a date and time like 12:00 AM on Friday. Thus, the RPA bot can serve as an independent automated process that does not demand human intervention in order to execute a work process and make or execute a decision if all the rules are clear and the decisions are pre-determined. RPA is very adaptive and fits many situations because of its internal capabilities.

RPA has several essential features that provide it competencies beyond those found in scripting, screen scraping, and sequential process management. 1) RPA utilizes dropping and dragging via icons that represent steps in a process. It is straightforward. Process code is then produced automatically without extensive programming, computer training or expertise. 2) The RPA bot accesses data produced by other computer systems or programs. It emulates exactly how an employee accesses this information (because the bot is created to do just this task). RPA can assume that logon ID and password are required to access what is normally seen or obtained by the worker from the other system's presentation layer. Therefore, the RPA bot is never interfering or invasive. 3) Finally, RPA is a secure and scalable technology that executes on the enterprise-protected platform. It can be configured, audited, and managed at the enterprise or organizational level that utilizes this technology.

The output of this bot appears to work "like a macro," but with more capabilities and functionality that is not restricted to an application like Word or Excel. Think of a very smart, tireless, and sophisticated desktop assistant. The bot is a powerful "aid" that performs scripting and screen scraping (record and replay), acts quickly, and is able to record (without error) what it is doing. Then the bot aid replicates the assigned task repeatedly – like a true robot. It is trained by watching worker selections, recording mouse clicks, matching inputs from the key board and completing the process as the user does. However, the bot is not intelligent – and does not know why it is doing this work since it only performs the assigned set of actions when called upon. (Madakam, Holmukhe, & Jaiswal, 2019; Peláez, & Kyriakou, 2008; Schmitz, Dietze, & Czarnecki, 2019).

5. CONCLUSION

The limited research and descriptive case studies suggest that RPA may have substantial potential for information systems integration in routine and standardized tasks that involve legacy systems.

RPA focuses primarily on the transactional processes that occur with more routine processes and back office work. However, the future for RPA might well include bots that learn and implement analytical processes, and complex work steps requiring more reasoning. They could act as a human might respond to data or situations that are more involved. RPA may evolve into more sophisticated processes that can modify the response required, and evaluate the data in light of the context or concern as well as interact and iterate steps and responses.

To accomplish this in future applications, RPA will need to comprehend and understand contextual situation. Artificial intelligence (AI) and machine learning algorithms, and cognitive computing systems can respond in this manner. However, these tools are trained to recognize and respond appropriately, and not programmed to be "intelligent." The future of RPA may be to work beside and integrate with employees to aid humans and support decision making with more and more detailed analysis. (Schmitz, Dietze, & Czarnecki, 2019; Slaby, 2012; Willcocks, Lacity, & Craig, 2015).

6. RECOMMENDATION: WHEN AND HOW SHOULD RPA BE USED?

IT processes have been targeted as work processes where RPA can deliver significant benefits for about 10 years. The more general characteristics of processes which may benefit most are predicted to include those with: high volumes and value of transactions, frequent access to multiple systems, environment stability, limited need for human intervention and exception handling, manual, prone to errors or re-work, and readily decomposed into steps with , and with a clear understanding of current manual costs. Eight use cases that are targets for this technology include server support, storage, networks, application, security automations, account identity and password management, automated job scheduling, and ITPA integration. The potential benefits include IT service: repeatability, predictability, integration, productivity, satisfaction, risk reduction, cost effectiveness, and improved business performance. (Fung, 2014)

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