Project Management Intelligence—Mastering the Delivery of Life Cycle Solutions

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Introduction

The importance of projects and service-oriented business models has grown over the years, encouraging companies to shift their business models toward the delivery of life cycle solutions (Davies et al. 2007; Gebauer 2008). Project-based firms (PBFs) operate in knowledge- and service-intensive industries and provide customers with long-term solutions based on combinations of products and advanced services (Davies et al. 2007; Hobday 2000). Integrated solution (IS) providers operate as PBFs, where projects are regarded as solutions comprising a product and service offering. In the project business, information acquisition and learning from previous experiences are core capabilities

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M. Kohtamäki (ed.), *Real-time Strategy and Business Intelligence*,
DOI 10.1007/978-3-319-54846-3_9

supporting competitiveness and the survival of a firm and enabling the development of long-term relationships with customers (Koskinen 2012; Blindenbach-Driessen and van den Ende 2006). In a continuously evolving environment, PBFs have to retain a dynamic and adaptive approach to changing customer needs and to the continuous optimization of products, services, and processes (Stringfellow and Bowen 2004).

In order to enlarge the knowledge base, optimize internal processes, fully grasp the needs of customers, and satisfy their requirements throughout the project life cycle, firms are increasingly adopting the use of business intelligence (BI) and transforming themselves into intelligent learning organizations. Business intelligence systems are data-driven decision support software solutions to gather, store, process, and analyze data and enable better decision-making in PBFs through all the stages of the project life cycle: consultative selling, conceptual design and customization, product and service configuration, installation, delivery, training, spare parts, updates and upgrades, maintenance, and diagnostics.

Research contributions on business intelligence in PBFs are limited, and accordingly, this chapter provides new insights by illustrating the role of business intelligence in the delivery of solutions. Additionally, this chapter sheds light on how integrated solution providers operate as PBFs through the integration of separate project business and service business units (Gebauer et al. 2010). This chapter explicates a step-by-step project delivery process and also outlines how to use business intelligence to successfully deliver solutions as projects.

The reminder of the chapter is organized as follows: In the following section, the nature of the project business and project-based firms is discussed, and a theoretical framework underlying the project delivery life cycle is presented. The same section also presents the managerial implications relating to how to deliver solutions as projects. In the third section, the various types of business intelligence tools used in the project delivery process are discussed, and the managerial implications of integrating BI tools in projects are reviewed. In the fourth section, the role of project learning in project-based firms is examined, and the managerial implications of facilitating within and across the project learning

with business intelligence are presented. In the conclusion, the future of Project Management Intelligence is discussed and the scope of the chapter is summarized.

Project Business and Project-Based Firms

The term project-based firms or PBFs emerged from the project business literature, where such a firm is characterized by its delivery of complete project solutions to customers (Hobday 1998). Traditionally, the project business is defined as business or "the part of business that relates directly or indirectly to projects, with the purpose of achieving the objectives of a firm or several firms" (Artto and Wikström 2005). Project business is driven by the demand for customized project deliveries, and PBFs are usually engaged in several projects simultaneously (Artto and Kujala 2008). Projects exemplify complex combinations of product and service offerings and steer the growth of project-intensive industries that include manufacturing, construction, and automation technology (Hobday 2000; Davies et al. 2007). In practice, project business can be broadly portrayed by two related concepts: project business as the delivery of an external solution to a customer and project business as an internal solution for the company's own business (Artto and Kujala 2008). The projects delivered by PBFs can be divided into business projects and innovation projects: Business projects refer to the projects delivered at the request of a particular customer, while innovation projects are targeted at the development of systems and services for a variety of customers (Blindenbach-Driessen and van den Ende 2006).

Integrated solution providers are essentially PBFs where the projects concerned involve delivering solutions comprising both products and services (Brady et al. 2005). The focus of this particular type of project-based firm is on customization and the delivery of complex solutions and systems to customers through an organization-wide integration of project and service units. The solutions delivered by project-based firms cover the entire system life cycle, including the development and the delivery of both the project and the subsequent services (Davies et al. 2007; Hobday 2000).

Delivering added value to customers through life cycle projects refers to the integration of services into the core business, resulting in long-lasting relationships with customers, and greater revenue and profits (Davies et al. 2007). Projects vary depending on the characteristics of the industry (e.g., the development of information systems, and/or of software systems, product and/or service design and installation, and operations outsourcing) and size (small-, medium-, and large-sized projects). Similarly, the type of project business determines the organizational flexibility and complexity.

The provision of comprehensive integrated solutions consisting of products and services is the key vehicle supporting solution providers in creating long-term continuous relationships with customers. The level of service offering depends heavily on the solution provider's business logic and the weight of benefits and drawbacks. Prior research distinguishes three types of solution delivery, which can be used to understand the projects at the solution level, those are: (1) transactional project deliveries; (2) project-led solutions; and (3) life cycle solutions (Kujala et al. 2011). Transactional project delivery implies simple project deliveries to a customer with a transactional service offering (spare parts, training, or support services) or no service offering. A project-led solution comprises core project delivery with an additional operation and management (O&M) service component. A life cycle solution includes a project delivery and O&M service as a single integrated solution and is focused on customer-based customization and a full-service project life cycle (Kujala et al. 2011).

Project Delivery Life Cycle

The integration of product and services in integrated solution providers corresponds to the integration of the project business unit and service business unit within PBFs. In such PBFs, products and services are delivered throughout sequential stages of the project life cycle from the project phase to the operations phase (Davies 2004; Cooper and Budd 2007). The responsibility for project delivery is broadly divided between the sales, project business, and service business units (Artto et al. 2015) (Fig. 1).

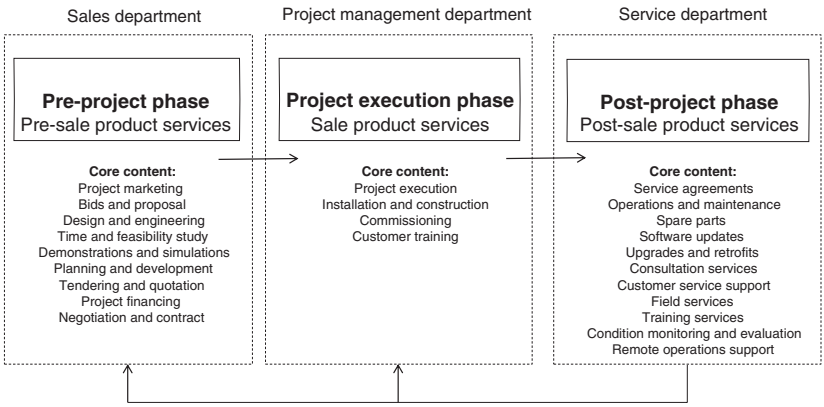

Fig. 1 Project delivery life cycle in PBFs

All three units complement each other and support the division of responsibilities and a controlled delivery of solutions to a customer. The core function of the sales and project business units (Cooper and Budd 2007) is the delivery of a product component: negotiating the offer with a customer and executing the delivery of the project. The service business unit is responsible for the delivery of the service component as a part of a single integrated solution. In the pre-project phase of the project delivery life cycle, sales managers identify customer needs, prepare a quotation and design, offer a solution based on customer needs, and then negotiate and draft the contract. Next, in the project execution phase, project managers implement the planning, execution, and the delivery of the project to the customer. Finally, in the post-project phase, service managers deliver O&M services including service contracts, diagnostics, spare parts, consulting updates, and upgrades (Artto et al. 2015; Kujala et al. 2011, 2010; Turkulainen et al. 2013).

Despite consisting of three sequential phases, the project delivery process is not linear in nature, but dynamic and continuous. Preventive and proactive maintenance business intelligence tools used in the post-project phase support the decision-making of service managers and generate recommendations on further operational efficiency improvements in the product offering. As a result, service managers transfer the need for a retrofit solution or a software update to

the project management or sales department, which again becomes involved in the project life cycle. The use of large sets of data to compare product performance across different customers can reveal product malfunctions and software deficiencies, the knowledge that is in turn transformed into vital lessons learned practices (Milton 2010; Weber et al. 2001) for the R&D department for further product–service innovation (Chirumalla 2016). Therefore, the project delivery life cycle not only contributes to short- and long-term asset performance from the customer perspective, but also generates large sets of historical data supporting product and service development in project-based organizations.

Service offerings at the different stages of the project delivery life cycle provide financial, strategic, and marketing benefits to PBFs (Kujala et al. 2013). Drawing on the classification of product services (Mathieu 2001; Frambach et al. 1997), service offerings in PBFs cover the entire life cycle of the project delivery, depending on whether they are offered before, during, or after the project sale. During the pre-project phase, pre-sale product services support customers in the purchasing process through customization, product, and service demonstrations. Sale product services support customers during the project execution phase through planning, system installation, and technical assistance. At the post-project phase, post-sale product services ensure customer satisfaction through maintenance, diagnostics, and operation support services (Mathieu 2001; Frambach et al. 1997). Service offerings provide PBFs with detailed insights into customers' internal processes, enabling the delivery of customized and competitive projects, and leading to the creation of long-term customer relationships (Kujala et al. 2013).

While service offerings play an essential role for customers, six impact types can be distinguished to provide an outline of how services also impact business performance in project-based firms: (1) customer entry; (2) customer value; (3) competitive advantage; (4) delivery efficiency; (5) service business; and (6) innovation and learning (Artto et al. 2008). Customer entry refers to the service serving as an entry point to a customer's business. The service offering provides more opportunities to maintain a relationship and access customers during different phases of the life cycle solution. Customer value is the value of the service offering

to the customer itself. The service offering bundled with a product supports the customer's business, increases profitability, and provides other long-term strategic benefits. Given that services are difficult to imitate, an increase in the competitiveness of a product and service offering in the market generates competitive advantage from the perspective of a solution provider. Delivery efficiency depicts a positive impact of services leading to more lean and cost-effective internal processes. Training and education programs increase the level of competence, and supplementary industrial services lead to increased efficiency during the solution's life cycle. In addition to the impact of services on projects, service business itself generates value and profit through installations or customization activity. Finally, services contribute to innovation and learning. Services open new avenues for knowledge generation, the development of new capabilities and of improved products and processes (Artto et al. 2008).

Managerial Implications: Delivering Solutions as Projects

The trend toward the provision of solutions rather than individual products or services has been steadily growing among the world's leading firms. However, managing and maintaining customer relationships in a complex context is a challenging task and requires certain measures. Services play an important role in the project business because they offer a continuous source of revenue and enable project managers to overcome what are termed sleeping phases in business projects. Prior research encourages project managers to systematically integrate the project business and service business, instead of solely relying on the pure combination of different departments. The choice of the project manager is very important, as the role is central to the integration of the project and service business units. Integrated solution providers should consider choosing a service-oriented project manager from the service unit, someone able to ensure the delivery of the solution throughout the project life cycle (Artto et al. 2015).

It is recommended that project managers involve customers in the process of decision-making on micro-level activities related to the project and service delivery. Customers tend to be interested in the detail

of the decision-making process, and such a strategic approach can contribute to building a stronger customer relationship (Artto et al. 2015). While project managers focus on the overall management of business projects, it is important not to neglect the role of front-line employees, whose behavior, competences, and motivation can positively or negatively contribute to the relationship with customers. Additionally, integrated solution providers should invest in internal marketing and provide incentives to employees to act as part-time marketers when they are with customers. These organizational mechanisms at the micro-level contribute in different ways to enhanced internal relationships and relationships with customers. To ensure the integration of both the project business and service business units, IS providers should continually focus on the development of a service-oriented mind-set, one that targets value co-creation with customers (Artto et al. 2015).

The integration of products and services is a challenging task, one that encourages PBFs to move away from traditional approaches and adopt smarter ways of working to survive in the dynamic and competitive environment. Therefore, the following section opens the discussion on how different BI tools can be utilized throughout the stages of the project delivery life cycle to facilitate efficient project delivery in PBFs. Emerging technology trends change the dynamics of inter-organizational processes, thus revealing the need for adaptation in the age of digitization. As a result, the ability of companies to stay agile and flexible is determined by their ability to adopt technology in the organizational architecture. As the vice president of R&D for the marine and energy solution company, Wärtsilä Ilari Kallio states: "Quick turns and sudden changes are the new world order. We must focus on maintaining agility and flexibility and ensuring we are equipped to embrace change." (Wärtsilä 2015).

Business Intelligence for Successful Project Delivery

In the project business and knowledge-intensive industries, project-based firms require a customer-centered focus to understand customer needs and deliver customized solutions. Evolving customer needs force

PBFs to maintain a dynamic and adaptive attitude to innovating new products and services and to the customization of those products and services (Stringfellow and Bowen 2004). To ensure that the organization can fully grasp the needs of customers and satisfy their requirements throughout the project life cycle, firms use flexible and intelligent technologies as they pursue the goal of becoming intelligent learning organizations.

As the complexity of projects increases, firms begin to adopt information technology platforms and tools to support the management of information. Information and communication technologies enable quick and easy access to the knowledge acquired in projects for everyone in a project-based firm (Loufrani-Fedida et al. 2014). Prior research emphasizes the need to strengthen information management systems to establish an organization based on learning capable of maintaining that learning basis throughout the duration of its projects (Hartmann and Dorée 2015; Chronéer and Backlund 2015). Previous studies focusing on knowledge management initiatives and learning processes offer evidence that technology and information system infrastructure have both enabled and hindered learning processes in PBFs (Moffett et al. 2003; Connelly and Kelloway 2003; Yeh et al. 2006).

Business intelligence systems used in PBFs are information-driven, stand-alone, or cloud-based solutions covering business analytics and performance management software. They gather, organize, process, store, and analyze data to deliver valuable insights to support project management. Business intelligence tools comprise decision support systems enabling the service offering in PBFs during the pre-project, project execution, and post-project phases. In PBFs, the services supported through the use of business intelligence tools are: consultative selling, conceptual design and customization, product and service configuration, installation, delivery, training, spare parts, updates and upgrades, maintenance, and diagnostics.

A considerable volume of research has addressed the specific business intelligence software applications used in the management of projects, which are known by the generic term project management information systems (PMIS). PMIS can help project managers to plan, control, and organize projects (Braglia and Frosolini 2014; Ahlemann 2009; Caniëls

and Bakens 2012). Demand for business intelligence applications has been growing, and multiple software providers, such as Microsoft, IBM, Oracle, and SAS, now offer customized stand-alone and cloud-based solutions. The common features of PMIS cover the following tasks: scheduling, planning, resource allocation, time and budget tracking, templates and deliverables, assignments, risk management, monitoring, and quality control (Turner 2009). PMIS support project managers in forecasting and forestalling issues with the delivery of a project, and hence help firms meet planned deadlines, increase efficiency, and deliver cost savings. As the complexity of the project management field grows, the focus of the PMIS shifts from single projects to "comprehensive systems that support the entire life cycle of project, project programs, and project portfolios" (Ahlemann 2009: 19; Braglia and Frosolini 2014).

The Guide to the Project Management Body of Knowledge suggests that project success "should be measured in terms of completing the project within the constraints of scope, time, cost, quality, resources, and risk as approved between the project managers and senior management" (Project Management Institute 2013: 35). Extensive research provides evidence of diverse business intelligence applications used for data-driven decision-making processes by project managers aiming to contribute to project success. Prior scientific research has focused on building an intelligent project-based organization model providing benefits to project-oriented organizations and enterprise intelligence (Oussama et al. 2013). From the risk management and controlling perspective, more and more companies get involved in using project management tools to improve the quality of project delivery, to decrease costs, and to meet deadlines. There are risk management decision-making tools that guide a project management team choosing how best to improve its project success rate while controlling the risks of doing so. The ProRisk methodology evaluates the impact of risks on project cost and schedule, so supporting the decision-making of project managers (Marmier et al. 2013; Nguyen et al. 2013).

With regard to project management critical success factors, the methodology developed by Constantino et al. (2015) aims to help project managers assess projects during the selection phase. Based on the artificial neural network, the model "acts as decision support system for the

project selection process highlighting early signs of failure by considering the alignment of a project with corporate strategy and the riskiness of the project acceptance" (Constantino et al. 2015: 1751). The model takes into account such project critical success factors as company strategic objectives, the project manager's experience, and the competitive environment. The model can be used in any industry and helps project managers to identify the key areas in need of improvement and where resources must be allocated throughout the project life cycle (Constantino et al. 2015).

Large projects (or megaprojects) combine multiple, related, and strategically aligned projects to generate greater value. Megaprojects require different decision-making processes of project managers than single projects, and information-feed is crucial in managing them. Information-feed refers to scanning internal and external environments in order to define and forecast the factors that could influence the firm and its objectives. Prior studies show that project managers feel more confident in dealing with ambiguity, risks, and uncertainty when supported by information-feed. As a result, firms should allocate resources and investments to maintaining an advantageous project risk management system (Coulter 2000; Eweje et al. 2012).

Business Intelligence Tools Used in Project-Based Firms

The business intelligence tools used throughout a project delivery life cycle comprise the following key systems: a product customization system, a sales configurator, a service support configurator, a design for manufacture and assembly, a project life cycle and tasks manager, a project portfolio management system, schedule management, document control management, a digital document repository, a project quality management plan configurator, a health, safety, security, and the environment (HSSE) incident investigation and reporting tool, commissioning management, project logistics and material management, a customer relationship management (CRM) system, a service cases repository, O&M reporting, a real-time monitoring and controlling system, remote access and support software, an inventory control

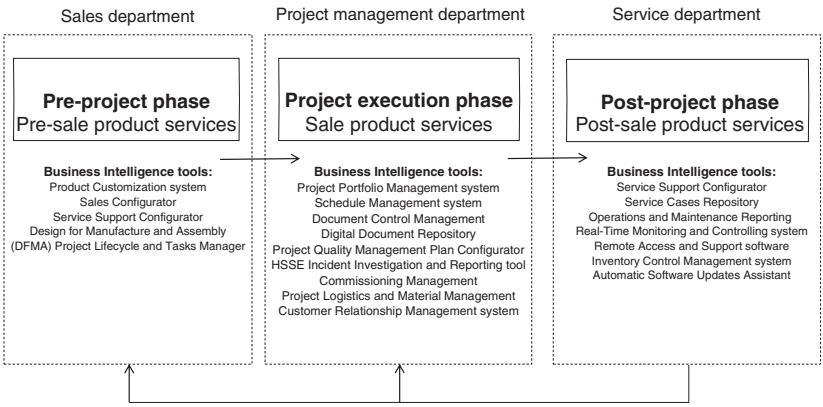

Fig. 2 Key business intelligence tools used throughout a project delivery life cycle in PBFs

management system, and an automatic software updates assistant (Fig. 2).

In the pre-project phase of the project delivery process, firms commonly use product and service configuration tools. Product and service configuration software supports sales and service managers in the process of creating pricing in real time and constructing quotations and proposals based on the customer needs and inquiries. Configuration management software helps managers understand customer needs and co-create project solutions alongside a customer. The system is based on the concept of guided selling, where managers are able to discuss different options with the customer by establishing the relevant technical parameters. One of the ideas behind the configuration tool is to highlight customer benefits instead of focusing solely on the technical details of the solution. For example, companies in manufacturing industries use configuration management software to show their customers a 3D model of their dream factory with smart automated manufacturing devices.

In the project execution phase, project-based companies often extensively use a project portfolio management system, and also a digital document repository, and a CRM system. A project portfolio management system is a centralized warehousing and reporting business intelligence

tool that supports project managers by offering an overview of current projects, so helping to prioritize tasks and allocate resources. A project portfolio management system helps managers to cope with large volumes of information, provides visibility of ongoing operations, and thus improves operational decision-making. The system offers a common platform for collaboration and storage of topical documents, so increasing the visibility of project activities and making the content of the project accessible.

A digital document repository is a document management system designed to save time for project workers when storing, searching, and retrieving documents. A digital document repository supports project execution by providing all users with access to data on past and current projects, marketing material, images, product layouts, and technical data. A customer relationship management system supports sales managers in acquiring customer data and helps generate the most suitable proposal for a customer. The system systematically stores detailed information on customer cases and facilitates the sales process starting from the initial contact with a customer. A CRM system also collates the information on customer interactions and applies pattern recognition analysis to the customer behavior so as to improve the customer experience and customer satisfaction. A clear overview of the sales network performance and the dashboard for monitoring key performance indicators often found in CRM systems facilitates the work of sales directors and can lead to long-term improvements in the solution sales process.

In the post-project phase, firms use a service case repository and O&M reporting software. A service case repository is a reporting and online analytical processing tool used in sales, project management, and the service business unit. The repository contains such information as issue and solution reporting, troubleshooting, maintenance logs, visualization dashboards, and real-time access to data on the condition and performance of the customer's product. A service case repository supports the work of project workers through its systematic collation of the history of customer maintenance cases, field service logs, triggers, alarms, and solutions to problems.

The reporting software designed for O&M issues comprises performance analytics and product condition management features.

The system provides service managers, engineers, and technicians with a complete overview of the entire product portfolio performance through sensors, cameras, and other devices connecting the customer product with the online cloud network. The system enables data monitoring in real time and supports the decision-making of service managers by generating recommendations on enhancing operational efficiency for customers. As the CEO of Finn-Power Oy (a member of Prima Industrie Group), Juha Mäkitalo highlights: "Closeness to the customer is at the heart of our industry. That's why as customer demands are evolving, we must embrace digital evolution and the opportunities it opens up. With tools such as big data analytics, we can make big inroads into service provision and enhance the customer experience" (CECIMO 2016: 5).

Managerial Implications: Using Business Intelligence in Projects

Despite the multiple benefits provided by business intelligence tools, its use can be challenging for project managers. While the importance of PMIS being user-friendly has been emphasized, practitioners have struggled with knowledge sharing barriers in the context of data codification (Santos et al. 2012). Knowledge sharing barriers such as inadequate IT, lack of motivation, resources, and time prevent business units from collaborating efficiently on projects by gathering and applying the knowledge learned from past projects (Ajmal et al. 2010). Firms have to ensure there are appropriate information systems supporting knowledge codification and sharing. Problems can arise if a knowledge sharing system cannot be integrated with other systems (e.g., e-mail or an intranet) or if it requires too much work (in terms of, e.g., logging in or navigation). Paying attention to and preventing such issues from arising can help ensure that employees use the PMIS. Additionally, project managers should provide proper training and incentives and encourage employees to use the BI tools. In the context of IS providers, a certain amount of time and resources must be devoted to dismantling any information barriers between project and service business units to ensure efficient knowledge sharing among units (Santos et al. 2012).

Prior findings (Caniëls and Bakens 2012) indicate project managers tend to use PMIS more frequently with multiple projects than with single projects, probably owing to the system's complexity and the time it demands. Information quality, project overload, and information overload determine the quality of a project manager's decision-making. As a result, a PMIS that is easy to use can positively affect the quality of decision-making processes. Research findings (Caniëls and Bakens 2012) suggest top management of PBFs should periodically obtain feedback from project managers on the quality of the data in the business intelligence tools. In a multi-project environment, project managers have limited time to verify the information held in the BI system. Hence, the continued use of BI by a project manager depends on how the manager perceives the quality of the information the information system supplies and the benefits conferred by the system (Caniëls and Bakens 2012).

Business intelligence tools support the decision-making processes of different business units throughout the stages of the project delivery process contributing to projects being delivered within the preset parameters of scope, time, cost, quality, and resources. Nevertheless, when operating in knowledge-based industries, project learning within and across projects is an important resource for project-based firms seeking to enlarge the knowledge base in the long term. As a result, the following section opens the discussion on the role of project learning in project-based firms, and how business intelligence tools can facilitate intra- and inter-project learning.

Project Learning in Project-Based Firms

In project-driven industries, knowledge management practices and project learning play an important role. Project-based firms strengthen their learning mechanisms and processes to advance the firm's progress toward becoming a learning organization in order to retain and improve the firm's competitiveness. A learning organization is defined as "an organization skilled at creating, acquiring and transferring knowledge and at modifying its behavior to reflect new knowledge and insights" (Garvin 1993: 80). In the context of PBFs, learning in projects can be divided

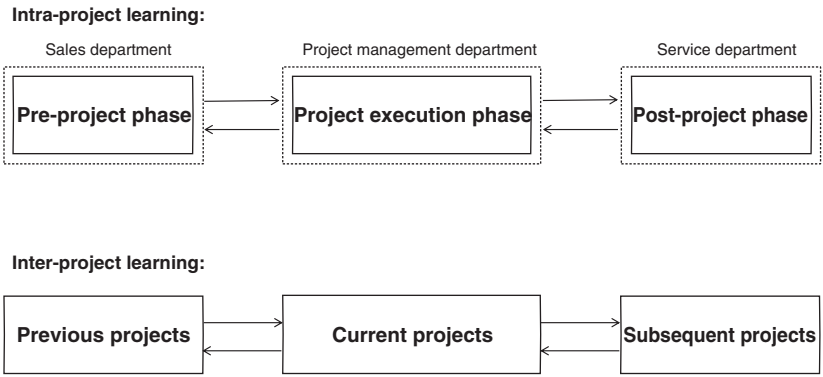

Fig. 3 Characteristics of intra- and inter-project learning

into two types: (1) intra-project learning and (2) inter-project learning (Fig. 3) (Kotnour 2000). Intra-project learning or within project learning refers to learning processes occurring within a project and facilitating successful project delivery. Inter-project learning or cross-project learning occurs when knowledge from past projects is shared across subsequent projects with the help of information technology or meetings (Kotnour 2000). In project-based firms and integrated solution providers, the learning process starts with intra-project learning. Knowledge acquired through that intra-project learning provides the pool of best practice and lessons learned for subsequent inter-project learning (Kotnour 2000).

Managerial Implications: The Role of Business Intelligence and Project Learning

Researchers including Chronéer and Backlund (2015) emphasize the need for firms to adopt a systematic approach toward intra-project and inter-project learning. It is recommended IS providers create "a lesson-learned cycle that collects and distributes experiences from stakeholders and thus contributes to a systematic evaluation and reflection during project closure" (Chronéer and Backlund 2015: 71).

In the pre-project phase, product and service configuration software facilitates intra-project learning through its connection to the enterprise resource planning (ERP) and automated data transfer from the pre-project phase directly to the project management department.

In the project execution phase, a project portfolio management system supports intra- and inter-project learning by providing different departments access to documentation on previous and ongoing project progress activities. A digital document repository supports learning within and across projects by collecting and storing data from different sources on previous and current projects available to all business units involved in the project delivery process. Customer relationship management tool facilitates both the intra- and inter-project learning of the sales department by collecting and storing detailed historical customer data throughout the project life cycle and enabling access to lessons learned from previous customer projects.

In the post-project phase, a service case repository contributes to within and cross-project learning by providing project stakeholders access to resolved service cases and real-time data on topical cases. In addition, lessons learned from resolved service cases support the R&D department in product innovation. Similarly, an O&M reporting system supports inter-project learning through continuously tracking product malfunctions, wearing-out of components, and software bugs as part of preventive maintenance contracts, thus contributing to product and service innovation in the long term.

Given that project-based organizations tend to focus more on problem solving than on project learning, project managers must nurture the learning culture within their organizations. Integrated solution providers should assign clear roles to project members in different project phases with the tasks related to systemic learning. Some roles should be assigned to project members who assimilate lessons learned across different projects, while the learning process owner should prioritize the knowledge derived and integrate useful experiences into practice. Knowledge sharing and integration may be fostered throughout the organizations by means of meetings or the use of different information communication technology solutions (Chronéer and Backlund 2015).

Technology is an enabling tool for the knowledge management culture; however, knowledge management processes in PBFs should be viewed not only through a lens of technology but also through a cultural lens. Organizational culture and people with different backgrounds contribute significantly to an effective knowledge management system. Global PBFs that target creating a knowledge management culture should look beyond the firm on an organizational level and should also pay attention to the cultural context. Prior research offers several sets of guidelines to help senior management and project managers to support knowledge management processes and develop a learning organization with people from different organizational, national, professional, and cultural backgrounds (Ajmal et al. 2009; Chirumalla 2016; Milton 2010).

First, to better organize the project learning process and transfer the lessons learned within and across projects, firms should ensure that employees involved in the project input the necessary documentation and information into the BI tools throughout the project delivery process, instead of doing it at the end of the project. At the end of the project, employees are usually assigned to new projects and project teams come under time pressure to fully document the lessons learned from the project. Additionally, because employees can struggle to recall the knowledge accumulated and valuable lessons learned throughout the project life cycle, inputting relevant data into BI systems at the end of the project can be challenging (Chirumalla 2016).

Second, knowledge documentation routines and the use of BI tools should be clear to everyone in the organization, and specific time and resources should be allocated to retaining acquired knowledge during and after each project (Ajmal et al. 2009). Project members should understand the fundamentals of knowledge management practices and their value. This could be encouraged by organizing seminars or workshops emphasizing the role of knowledge as the key resource in the organization (Ajmal et al. 2010).

Third, it is important to ensure staff understand the documentation policies and adhere to them as part of their daily routine (Ajmal et al. 2009; Chronéer and Backlund 2015). Project leaders should act as coordinators for the relevant employees, project, and service units to track

progress and ensure all project personnel use the available PMIS (Ajmal et al. 2010; Chronéer and Backlund 2015). Apart from project managers, senior management also have a key role in developing and facilitating the use of formal learning procedures and principles (Chronéer and Backlund 2015).

Another requirement for efficient project learning is to ensure that each department has a standard method for capturing lessons learned in BI systems throughout the project. Although BI tools used in projects differ to some extent, and reporting methods differ between departments, firms should develop a common standard policy to store the relevant lessons learned in different digital repositories to ensure data consistency (Chirumalla 2016).

Additionally, empirical research provides evidence that data reporting in BI tools through bullet points does not capture the lessons learned well and does not contribute to a rich project learning experience through BI-based knowledge repositories. It is recommended firms ensure that templates, spreadsheets, and reports in PMIS are flexible and provide project workers the opportunity to be effective in sharing their learning experience on certain topics, instead of roughly filling in all the empty (and sometimes irrelevant) blanks (Chirumalla 2016).

Finally, top management should encourage the development of a no-blame culture, where people are encouraged to be open about the knowledge held within their project team. Employees should be encouraged to share lessons learned and knowledge of job-related routines across project and department boundaries (Chirumalla 2016). The process of developing the learning organization may fail if a project manager is unaware of subcultural differences. Those who are aware can help head off conflicts and misunderstandings (Ajmal et al. 2009, 2010).

The Future of Project Management Intelligence

While the project data volume continues to grow, it is important to tackle the issue of how different factors are shaping the future of Project Management Intelligence and what kind of emerging trends companies might face in the future. Digital business transformation is a journey,

not a destination. Therefore, companies should remain agile and treat digitization as a continuously evolving process.

The large number of BI tools used in the project delivery process is one of the key challenges that companies face at the moment. Organizations are failing to build a robust IT infrastructure, capable of integrating data from a variety of BI tools into a single platform, designed to fulfill employees needs to access project information without logging into each of the BI tools separately (McCullen 2009). In the future, Project Management Intelligence tools should be developing toward flexible integrated software programs and dashboards, providing a holistic view and improving organizational efficiency (Braglia and Frosolini 2014). Software providers and project-based firms should pay particular attention to middleware, which connects multiple BI applications together and allows the data available in one BI tool to be accessed through another.

As project-based firms continue to generate ever larger volumes of data, so the variety of different BI tools to analyze the data can be expected to grow and improve. The field of Project Management Intelligence will experience a shift toward an extensive use of predictive and prescriptive analytics in the future, which will be driven by machine learning and artificial intelligence. Project Management BI tools will calculate the value of different scenarios and the impact of future decisions based on the numerous data points and calculations. Decision-makers will be able to apply analytics to predict what is going to happen, when it is going to happen, and why it is going to happen, thus using prescriptions to shape the desirable future.

Companies operating in a digital age must not only transform internal business processes and software, but also transform their organizational culture and train their employees to be more responsive in the process of becoming a data-driven organization. It is predicted that the data-driven business and BI-enabled decision-making will become a standard practice in organizations, which will also require skills appropriate to using insights effectively. As the number of projects and the volume of data will grow, companies will recruit specialists such as *data translators*, who can analyze and derive the most useful insights from data. Additionally, companies will support employees involved in

the project delivery process to develop new sets of advanced analytical skills to understand statistics and align project insights with business decisions.

Conclusion

This chapter provided insights for business practitioners into how different business intelligence tools can be used throughout the stages of the project delivery process in project-based firms: the pre-project phase, project execution phase, and post-project phase. Business intelligence systems facilitate the intra- and inter-project learning occurring in project-based firms and contribute to both short-term and long-term project management performance. Knowledge sharing tools facilitate the decision-making processes of project managers, sales managers, and service managers; however, such barriers as inadequate IT, lack of motivation, resources, and time can hinder the performance of business units at the individual and organizational levels. The role of projects and the delivery of customized solutions are growing and are changing firms' internal processes and learning mechanisms. Learning organizations are considered to offer advantages that include nurturing a learning mindset, creating, absorbing, and exploiting the knowledge gained from outside or inside the company. In the current context of digitization and the shift toward intelligent technologies, companies should increase their flexibility and continuously innovate in and optimize their internal decision-making processes to remain competitive.

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