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STRIVING FOR CONTINUOUS PROCESS IMPROVEMENT IN CONSTRUCTION – A CASE STUDY

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ABSTRACT:

Organisations must constantly monitor, measure, evaluate and improve their processes in order to remain competitive. Construction organisations are no different in this aspect and are increasingly realising the need for process improvement due to external and internal pressures. The construction industry is working towards improving its efficiency by implementing process improvement techniques such as Lean Construction along with information and communication systems. Business processes and information technology are closely associated and better results can be achieved by addressing them in an integrated manner. This paper provides details of a case study where an extensive business process improvement exercise was carried out over a period of five years alongside a major Enterprise Information System implementation. All major organisational units were assessed and its processes were modelled and evaluated with a view to improvement within the lean framework. Finally a continuous process improvement framework was put in place to avoid the risk of stagnation. The lean continuous improvement framework resulted in each organisational unit taking responsibility for their own processes ultimately leading to higher profitability and smoother supply chain processes. The case study also demonstrated that even smaller business units and its processes affected the overall value chain in a major way and the importance to analyse the process interdependencies between organisational units.

KEY WORDS: Lean Construction, Organisational Process Improvement, Process Modelling, Continuous Process Improvement

INTRODUCTION

The dynamic and turbulent nature of the business environment necessitates critical process evaluation and change. Organizations must constantly monitor, measure, and improve their processes if they are to survive in today's dynamic business world. Businesses in private and public sectors have devoted increasing attention to business processes for several decades. This interest has grown out of the need to streamline business operations, consolidate organizations, and reduce costs, reflecting the fact that the process is the basic unit of business value within an organization. By

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definition, a business process is any sequence of structured or semi-structured tasks performed in series or in parallel by two or more individuals to reach a common goal. Simply put, it is the set of activities an organisation pursues to accomplish a particular objective for a particular customer, either internal or external.

Process improvement is not a new concept; the roots of current industrial process initiatives can be traced back to the early 20th century when Henry Ford introduced the assembly line production at Highland Park plant to build cars (Liker, 2005). By using assembly line, Ford significantly reduced the cost and time to produce cars, making them affordable to the American public. Also around this time, Frederick W. Taylor (1914) published a seminal book: *Principles of Scientific Management*. Scientific Management involved breaking the manufacturing process down to a thoughtless cycle of simple sequences, which were to be carried out in the least amount of time possible with the minimum amount of effort. Taylor's book had a profound effect on the management community and he is widely regarded as the father of operational research (Nelson, 1980). These activities paved a new path for recognising the importance of conducting serious process analysis activities.

The platform for the current emphasis on the comprehensive business process change initiatives was laid by Michael Porter (1985) in his book: *Competitive Advantage: Creating and Sustaining Superior Performance*, where Porter introduced the concept of value chains – a comprehensive collection of activities performed to support a product/service. Although it was Porter who pioneered the concept of value chains, the interest in the current business process change can be attributed to the Business Process Reengineering (BPR) movement that began with publication of two papers: Michael Hammer's "Reengineering Work – Don't Automate, Obliterate" and Thomas Davenport and James Short's "The New Industrial Engineering: Information Technology and Business Process Redesign". Both these papers focussed on process redesign initiatives to leverage maximum potential from information technology/systems. Both – Davenport and Hammer suggested that organisations should focus on the whole process rather than just one part of the process leading to very large scale process improvement projects across organisations.

Somewhat in parallel to the above mentioned developments a different process improvement technique called "Lean Thinking" emerged from the East, within the Toyota's manufacturing system. Lean Thinking was pioneered by Taiichi Ohno of Toyota who identified seven different wastes within the production process and proposed that they should be eliminated/optimised in order to improve the process efficiency. The concept of lean production was made popular by James P. Womack and Daniel T. Jones who published a book called "Lean Thinking" and "Machine that Changed the World" based on the Toyota product development process.

The work presented in this paper was a part of a major process improvement project in a large-size construction company, which was conducted in parallel to a business Information System implementation project. The company had realised that it is essential to understand the business process in hand before improving or automating it. By simply implementing a new technological solution and replicating existing processes will not improve the organisational efficiency (if not reduce it). The existing Enterprise Information System used by the company was implemented 15 years ago and hence it had been a while since the company carried out a root and branch audit of its business processes. As a result the company decided to carry out a

business process modelling and improvement exercise to complement the Enterprise Information System implementation.

A critical review of current and emerging business process modelling techniques was undertaken first to identify best-suited method for the project. Once identified, the process modelling technique was used to map out the business processes and recognise critical value chains, which offered scope for improvement. Once the modelling was complete, processes were analysed using a process improvement framework based on lean principles.

In the following section we provide a brief overview of the above mentioned process improvement and modelling techniques and a discussion about how they compare.

A REVIEW OF BUSINESS IMPROVEMENT APPROACHES

In this section, a brief review of the three most significant approaches to business process improvement is presented: Business Process Re-engineering, Process Innovation and Lean Thinking. A critical discussion of these approaches is presented and lessons learnt from the past are identified, together with a methodology, which has helped in shaping the thinking on the approach that was taken in the case study.

BUSINESS PROCESS RE-ENGINEERING

Business process reengineering, emerged in the early 1990s as an approach to fully exploit the potential of Information Technology to increase organisational efficiency. In an aggressive and often provocative article entitled “Reengineering Work: Don’t Automate, Obliterate,” Hammer (1990) advocates the need for a radical reengineering of processes in order to fully exploit the potential offered by information technology: “It is time to stop paving the cow paths. Instead of embedding outdated processes in silicon and software, we should obliterate them and start over.” This article aroused significant interest and debate and it encouraged Hammer together with Champy to publish the book ‘Re-engineering the Corporation: A Manifesto for Business Revolution’ (1993). This book became the most widely sold management book of the 1990s. They define re-engineering as ‘...the fundamental rethinking and radical redesign of business processes ...to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service and speed.’ That is, not small incremental changes to the process and leaving the basic structures intact, but rather, abandoning long-established procedures, conventional wisdom and assumptions from the past, to look afresh at the work required in creating a company’s product or service to deliver direct value to the customer.

According to its advocates, reengineering is not simply a quick fix approach for managers seeking to improve the efficiency of outdated administrative functions, as its fundamental message concerns long-term organizational transformation. Re-engineering is a top-down approach led by senior management and aimed at rapid and dramatic performance improvement. It views improvement from the process perspective rather than the functional or organisational stance and is intended to align the process with the strategic objectives and customers’ needs. Although many authors have proposed various approaches to BPR, these are very similar and essentially involve the following broad steps: developing a vision; identifying and

understanding the current process; redesign the processes; and implement the redesigned processes.

PROCESS INNOVATION

Davenport (Davenport, 1993) developed the concept of process innovation, which he claimed was different from process reengineering. Davenport held the view that in the face of intense competition and other business pressures on large organizations in the 1990s, quality initiatives and continuous, incremental process improvement, though still essential, were no longer sufficient. The needed a revolutionary approach to business performance improvement which must encompass both - how a business is viewed and structured, and how it is improved. Business must be viewed not in terms of functions, divisions, or products, but of key processes. Achievement of order-of-magnitude levels of improvement in these processes means redesigning them from beginning to end, employing whatever innovative technologies and organizational resources are available.

Process Innovation combines the adoption of a process view of the business with the application of innovation to key processes. Davenport claimed that what was new and distinctive about this combination is its enormous potential for helping any organization achieve major reductions in process cost or time, or major improvements in quality, flexibility, service levels, or other business objectives. Davenport preferred to use the term Process Innovation to describe radical process change initiatives, which had hitherto been called various names such as business process redesign and business reengineering. Davenport held the view that reengineering is only part of what is necessary in the radical change of processes. It refers specifically to the design of the new process. The term process innovation encompasses the envisioning of new work strategies, the actual process design activity, and the implementation of the change in all its complex technological, human, and organizational dimensions.

Davenport outlines a framework for process innovation that consists of five steps: identifying processes for innovation; identifying change levers; developing process visions; understanding existing processes; and designing and prototyping the new process. This framework shows many similarities with the work of Porter and Millar (1985) and McFarlan (1984) not to mention BPR as advocated by Hammer and Champy (1993) because it invites managers to carefully consider their innovation and change strategies. Along with the previous authors, Davenport's work is prescriptive as it advocates that senior managers should engage in "process-oriented thinking." Yet unlike the previous studies, the above framework for process innovation places a greater emphasis on perceiving business activities as a series of interrelated processes, with the recommendation that firms should examine their processes to eliminate or develop new processes. One of the attractions of process innovation is that developments in information and communications technologies have led to functional integration between and within companies, suppliers, and customers.

LEAN THINKING

Lean thinking provides a way to specify value, line up value-creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively. In short, lean thinking provides a way to increase efficiency using fewer resources while achieving better

customer satisfaction (Womack and Jones, 1996). Lean thinking emerged from Toyota's production system after the World War II where Taichi Ohno pioneered a way to produce better quality cars at less cost than western competitors. Lean thinking was made popular in the western world by Womack and Jones when they published the book "The Machine that Changed the World" in 1990 and "Lean Thinking" in 1996. Toyota achieved a streamlined process which was owned by its employers and closely integrated with the supply chain to remove unnecessary buffers. Although the idea seems simple – identify and remove waste from organisational processes and put customers in focus - it is a complex concept to implement.

DISCUSSION

There are many similarities in the BPR approach of Hammer and Champy and the Process Innovation approach of Davenport. In the BPR approach, Davenport and Hammer lay much emphasis on comprehensive processes thinking, similar to Porter's value chains. They argue that focusing exclusively on a sub-process, such as new product development or marketing, may lead to improvements in that sub-process, but not in the business overall. In the worst scenario, the sub-process may be improved at the expense of the overall value chain. The BPR advocates recommended that companies define all of their major processes and then focus on the processes that offered the most return on improvement efforts. Information Technology was a major catalyst of the BPR movement, as Davenport argued that information technology had made major strides in the 1980s, and was now capable of creating major improvements in business processes. Hammer argued that previous generations of managers had settled for using information technologies to simply improve departmental functions. In most cases, the departmental functions hadn't been redesigned but simply automated, thereby maximising departmental efficiencies at the expense of the overall process. Hammer argued that what was needed, was a completely new look at business processes. He claimed that huge improvements could be achieved if companies were able to withstand the pain of total business process redesign. Hammer and Davenport both argued that processes should be integrated in ways in which they hadn't been in the past. They called for processes to be conceptualised as complete, comprehensive entities that stretched from the initial order to the delivery of the product and that Information Technology should then be used to integrate these comprehensive processes.

Some of the BPR projects undertaken in the mid-1990s succeeded and produced impressive gains in productivity and many others failed and produced disillusionment with BPR (Hall, Rosenthal and Wade, 1993), which has prompted many researchers to focus on identifying success factors behind BPR implementation (Bashein, et.al., 1994; Caron, et.al., 1994; Earl, et.al., 1995). BPR has been used as an umbrella term covering a range of business reorganizational activities. However, it has also come under criticism from many experts due to its failure to achieve any significant improvement in many of the projects. Davenport and Stoddard (1994) have reported, "BPR has been widely misunderstood and has been associated with downsizing, quality, activity based costing and many other management activities in past several years. As a result many managers pursued reengineering due to the positive review it received without really understanding what reengineering really is." In a critical review of BPR philosophy (Biazzo, 1998) has suggested that BPR approach does not

take into account the social aspect of organisation and considers organisations populated by infinitely malleable people and that it should be not be used any more. This view has prompted many researchers to investigate the role of human factor in the implementation of BPR (Katzenstein and Lerch, 2000; Roy, et.al, 1998) signifying the importance of human capital in organisations (Palmer, 1997).

On the other hand, Lean philosophy proposes equilibrium between people, process and technology. Empowerment of People is significant in Lean as workers are given responsibility to control and improve their own processes. It is also more sustainable as it proposes close integration with suppliers to achieve a long term relationship based on trust and mutual benefit. As a result Lean philosophy has gained stronger ground as a process improvement philosophy in organisations. For this reason, Lean was used as a process improvement technique for the case study presented in this paper.

CASE STUDY

Founded in 1935, Pochins PLC is a construction and property company operating mainly in the North-West region of England. Apart from construction, which is its main business, Pochin Group has other subsidiary companies dealing in Concrete Pumping and Commercial and Residential Property Development. The company employs around 500 employees including all offices and subsidiaries, out of which around 300 are based in its Cheshire based office. The company had a turnover of £77.7m in year 2005, and £130m in the year 2006. Nationally, Pochin enjoys the leading position in the concrete pumping business with a wide fleet of concrete pumps and depots across the country.

Pochins promotes innovation within the organization and this is reflected in its business strategy. Pochins recognized that it needs to continuously monitor, measure, and improve its processes if it is to build on and improve its competitive position within today's dynamic business environment. Thus, it had embarked on a business process improvement exercise to radically review its current processes with a view to eliminating wastes, streamlining processes, and rendering them fit for the digital age.

THE PROBLEM CONTEXT

Pochin group had been subjected to a significant expansion during last ten years, as its turnover increased significantly during the period. Pochins also made some important business acquisitions during this period including the acquisition of Pipeline drillers, a company specialising in trenchless technology services.

The past few years had seen a revolution in the availability of information technology solutions to the construction industry. Construction being an information intensive industry it is of greater importance to Pochins to adapt to the changing environment and continually review it's IT and business strategy. Pochins have responded well to the challenge and have been implementing various information systems along with the hardware and communication systems required. However, it is very difficult to keep pace with this challenge as IT industry is moving at a fast pace with new solutions being introduced to the market at very short intervals, and what is new today becoming "obsolete" in less than a year's time.

The Pochins Group had been using an ERP solution for its core accounting and other support functions many years. However, the rapid developments in ICT combined with its recent expansion strategy had necessitated the replacement of this

legacy solution. Pochin also recognises that a more important issue than just implementing IT solutions is to review how these solutions can bring actual benefit to the business itself. Research has shown that merely automating manual tasks will not bring any significant benefits to the business. However, reviewing the processes to eliminate wastes and add value whilst implementing an IT solution will ensure that an organization gets the best out of its investment, hence it is imperative that the business process review and IT system implementation complement each other and should be carried out in parallel (Dave et al., 2008). Harmon (2003) has proposed a comprehensive yet generic methodology consisting of the following 5 phases:

Phase 1: Planning a process redesign effort

Phase 2: Analysis of an existing process

Phase 3: Design of a new or improved process

Phase 4: Development of resources for an improved process

Phase 5: Managing the implementation of the new process

These phases are self-descriptive and will not be described here and the reader is referred to Harmon (2003) for a detailed description of the methodology and the 5 phases. This methodology has been adopted in the case study presented here.

PLANNING FOR THE IMPROVEMENT EFFORT

Process improvement is a complex task requiring careful planning and implementation. It is important to identify the aim and objectives of the project beforehand to make sure the project focus is on the right processes. A steering committee was established consisting of a board level director, IT manager and a process management consultant. Individual consultations were undertaken with the senior managers of respective departments to identify their departmental priorities for improvement. This was followed by several meetings between the senior managers to share a common understanding and to develop a consensus on the priority areas to be improved. Lessons learnt from previous business process modelling initiatives indicate that the effort should initially focus on a small number of high priority areas that will add the greatest value. The priority areas identified included communications, estimating and tendering, materials and sub-contract procurement, and business development. The steering committee then developed and approved a plan that established the goals of the project and a schedule to complete the initiative within two years.

ANALYSIS OF EXISTING PROCESSES

The key to the analysis of the existing processes within Pochins was to develop a detailed understanding of how they currently worked. This was to be achieved by producing process maps or models as these provide a means of communicating complex business functions in a form more easily understandable by people. Initial work focused on eliciting the data required to carry out the process mapping and improvement. An organisation chart was produced to identify and document various functions across the organization and to understand how the company is structured internally. An organizational diagram was produced to understand how the company related to its environment. These gave useful insights into the company and its core value chains. The organisational diagram indicated that various subsidiaries of Pochins share common business functions, for example IT & communications, business development and marketing etc. However, specialist functions such as

material procurement and estimating were kept separate. Following this, meetings took place with senior managers to identify champions from each department. These champions provided liaison within their own department and provided feedback to the project team. The data collection and process modelling strategy was formulated and approved by the steering committee.

ENTERPRISE MODELLING TOOL

The problem context expressed by Pochins implied that what it needed was an Enterprise Architecture solution which enabled it to be able to respond rapidly, effectively and positively to the opportunities and challenges presented by current and future market conditions, potential industry consolidations, and rapid technological advances. An Enterprise Architecture is a fully integrated collection of models of business processes, information, systems, and technology.

Thus, it was necessary to identify a tool that will facilitate this requirement. The tool selected was Telelogic's System Architect. It is an enterprise, business process, data, and system-modelling tool, which can be used to support organisations in aligning their business with IT. The foundation of the product is a multi-user common repository that enables the maintenance of a single knowledge base of operations and users to visualise the relationships between various objects from many different perspectives. It adopts industry standards, provides multiple diagramming techniques and modelling methods, and integrates many frameworks making the tool very adaptable and capable of meeting the needs of different users.

BUSINESS PROCESS MODELLING

A series of one to one interviews were carried out with process stakeholders to collect the information about the existing process. The data collected is being used to create process models across the organization in the priority areas selected. The process models were produced using the System Architect tool as indicated in Figure 1. Business Process Markup Notation (BPMN) was adopted as the process-modelling standard. Process models were used to model the existing processes ("AS IS") and the improved ("TO BE") processes. As it can be seen from Figure 1 each stakeholder is represented in a lane, these are called swim-lanes in BPMN. The entity containing swim-lanes is called a pool, which in this case can be Pochins Homes or Architect. The rounded rectangles represent tasks or processes, if there is a sub-process within a process it is depicted by a small "+" sign at the bottom of rectangle. The decision gateways are shown by the "diamond" shapes, and a document is shown by a rectangle folded on one corner.

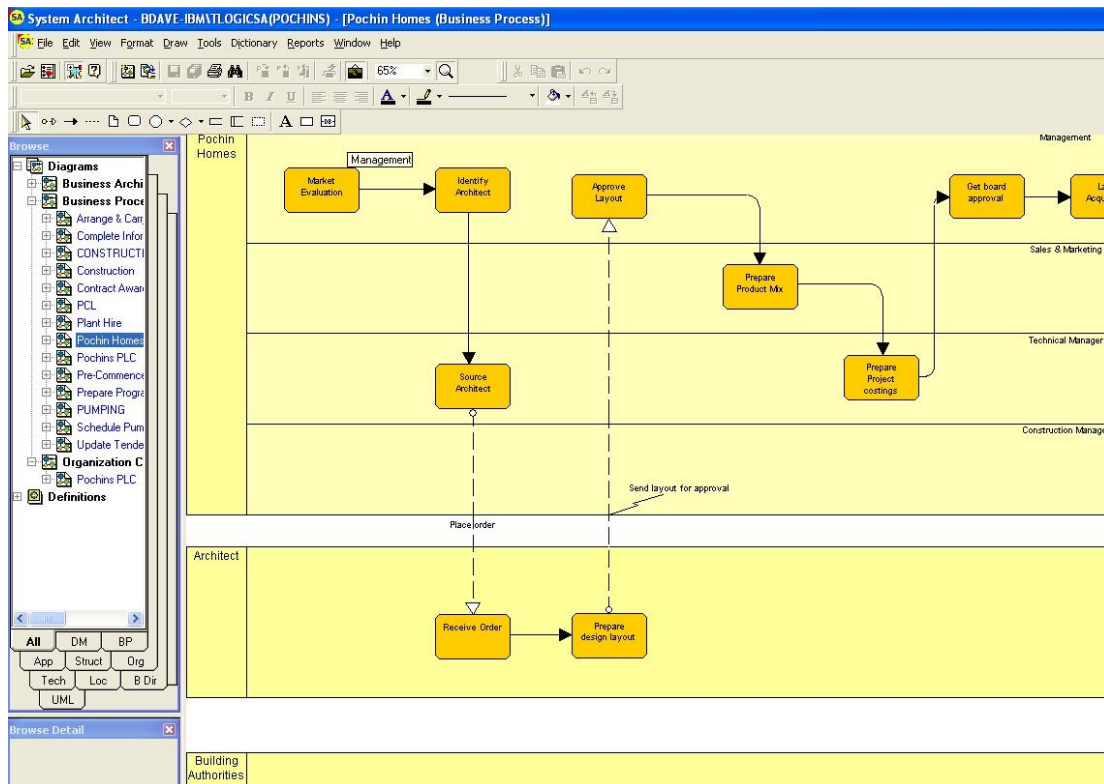


Figure 1 - A sample Business Process Model

CONTINUOUS PROCESS IMPROVEMENT FRAMEWORK

A framework using lean principles and knowledge of business processes was developed to assist in continuous improvement activities in future. It was essential to design such a tool which will assist in process analysis once the project is completed to leave a sustainable initiative. The key requirement for such a tool is that it should be easy to understand and maintain as it will be used by employees who do not necessarily have process modelling experience. Hence a tabular representation of all processes was created to identify inefficiencies present within the process along with a comparison of value adding/non-value adding time (

Figure 2). Initially, raw data was captured by circulating these process tables across the company for employee input. A workshop was then held to train carefully selected employees who will analyse these processes and then maintain the framework within the company.

Figure 2 - A sample continuous process improvement diagram

Process/Task	Participant	Defects	Waiting	Transportation	Inventory	Motion	Processing	Value adding time	Non value adding time (in minutes)
Receive external mail	Mail room assistant								
Open and date stamp mail	Mail room assistant						X		30
Sort mail by departments	Mail room assistant							60	
Send to directors for approval	Mail room assistant		X	X			X	10	60
Photocopy all site mail	Secretary		X	X			X		45
File all site mail	Mail room assistant						X		30
Post mail to site	Mail room assistant		X	X					30
Percentage								24%	76%

DISCUSSION

Process modelling and analysis are two of the most important aspects for any process improvement activity. Process modelling has long been used by the manufacturing, computing and automotive industries as a method to capture existing business situation and for analysis, simulation and automation purposes, where as construction industry is relatively new to the concept. As can be seen from the case study, the overall process improvement effort requires careful planning and consideration. The following were identified as the key success factors for process modelling and improvement activities from the case study:

1. Identification of appropriate methods for modelling and analysis
2. Support from the senior management throughout the project
3. Knowledge of the construction process possessed by the process modeller
4. Identification of core value chains and opportunities for improvement within the business
5. Relations between the process improvement team during the project

Apart from the above mentioned factor, one other key success factor is perseverance possessed by the process modeller and analyst. Projects of this nature require a significant amount of data collection from the employees at all level who are actively engaged in daily business activities. The project may suffer severely if time is not coordinated wisely as without the appropriate data process models become inaccurate and analysis becomes futile. Many process improvement projects do not achieve desired results due to lack of planning and understanding of the core business activities.

Positive points emerging from the project:

- A clear understanding of the current and proposed situation provided the much needed transparency to the process. This is essential to address the concerns of the employees in such a large change programme.
- Opportunity to maximise the exploitation of technology before it is too late (i.e. once old processes are replicated in the new system)
- Process Improvement Framework emerging from this project provided a sustainable initiative within the organisation.

Areas of difficulty

- Constant change in the business operations made it difficult to capture the process. It became an ongoing task to capture this information.
- Such a project requires significant resource allocation (especially employee time) within the organisation. This proved to be a difficult task considering the busy nature of construction personnel.
- Impacts resulting from such initiatives are not always possible to quantify immediately. It might even take 5 years for some changes to take effect. In an industry where immediate results are expected this is difficult to manage.

CONCLUSIONS

Process improvement is a strategically important activity for organisations today. Many techniques have been developed in the past century to assist companies in undertaking process improvement activities with varying degrees of success. Process improvement based on lean principles stands out distinctly from others as it directly addresses wastes lying within the system and helps organisations focus on value adding activities which lead to improved customer satisfaction. Lean is increasingly gaining popularity as the process improvement technique, however there are certain challenges involved in lean implementation, a significant one being change in the organisational culture. As lean emerged within Japan where organisational culture is significantly different in comparison with western countries, change management is a key task in such projects when carried out in western countries. However if conducted appropriately such initiatives bring significant benefits to the company as evident by the case study provided.

The AEC industry is constantly looking for ways to improve its efficiency. The manufacturing industry addresses the constant challenge of efficiency improvement by methodical process management initiatives. By employing techniques such as process modelling, lean principles and process analysis techniques, the manufacturing industry maintains a well performing process. As illustrated by the case study, such process management techniques can be applied to the AEC industry (here illustrated in the construction sector) which can then aim at process standardisation across the industry.

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