

NEW APPROACH TO BUSINESS PROCESS MANAGEMENT IN CONSTRUCTION COMPANIES

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Abstract

The challenge that construction companies are faced with at present is the unique character of each executed investment. Each subsequent project is different. The projects differ in terms of the constructed objects, their architecture and functions, client needs, the standard of internal finishes, and rules of cooperation with the investor. Even if the constructed object is following the same blueprint, it is nonetheless different in terms of its immediate surroundings, its neighboring infrastructure, access to the construction site, its organization, and the requirements of the investor or local authorities. On the example of leading Polish construction companies (belonging, in fact, to leading European companies), the article points to the challenges associated with implementing process management in construction companies. The unique character of each investment, their ever-changing conditions, and the concurrent complexity of the executed business processes require the companies to search for new methods of modeling and implementing process management. This requires an approach to process modeling, in which the fundamental goal is no longer the search for or the implementation of a single “ideal process.” The aim of the research was to find principles of practical process design; ones which would enable the adaptation of processes to the requirements of specific contracts in a transparent and workable manner. The article will showcase different attempts at overcoming these challenges, as well as point to the similarities between the prepared solutions, which account for the use of process management in accordance with the concept of dynamic BPM and alongside knowledge management from the onset of the modeling phase. The proposed solution uses the most popular BPMN 2.0 notation standard to model processes, which means that it can be used in standard implementations of process management.

Keywords: *business process management (BPM), unstructured processes, dynamic BPM (dBPM), process mining, communities of practice (CoP), business process management system (BPMS), knowledge management (KM), knowledge acquisition, active knowledge modeling (AKM), process-oriented knowledge management (pKM).*

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1. Introduction

Clients seek individualized products and services which are customized in terms of features, tailored to their individual preferences and habits, with instant on-demand shipping, an attractive price, and excellent quality. The expectations above force companies to change their management from market-oriented, and thus intended for the statistical, common-denominator client, in favor of management oriented on the individual client instead. This pertains to the construction sector in particular. A great challenge that construction companies are faced with is the unique character of each executed investment. Each subsequent project is different. The projects differ regarding the constructed objects, their architecture and functions, client needs, the standard of internal finishes, rules of cooperation with the investor, etc. Even if the constructed object is following the same blueprint, it is nonetheless different concerning its immediate surroundings, its neighboring infrastructure, access to the construction site, its organization, and the requirements of the investor or local authorities. In other words, no two construction projects are alike. The unique character of each investment, their ever-changing conditions, and the concurrent complexity of the executed business processes require the companies to search for new methods of modeling and implementing process management. Traditional, static process modeling, which concentrates on detailed descriptions of the logic behind executing a given process, leads to the creation of diagrams, in which “everything is connected to everything else”. In practice, it is indeed the case that a large number of process tasks must be followed up with the option of holding consultations or negotiations, restarting the execution, or delegating the decision to the supervisors. When we also consider the fact that the traditional approach to quality management and process management process performers must strictly execute processes designed by their supervisors, modeling becomes the proverbial mission impossible. How is it possible to combine a single process enforced throughout the organization with the full individualization of investor requirements? This requires an approach to process modeling, in which the fundamental goal is no longer the search for or the implementation of a single “ideal process”.

From the perspective of the organizations taking part in the project the aim of the research was to find principles of practical process design; ones which would enable the adaptation of processes to the requirements of specific contracts in a transparent manner transparent to the process performers, and one which enables the management of the investment execution. At the same time, the principles of describing and executing processes which were formulated in the course of the research had to enable the analysis of ongoing or finished processes. Finding the answer to this

fundamental question depends on answering several other, seemingly basic questions: When should organizations implement dynamic business process management? What risks are involved with the traditional, static management of processes which are dynamic in nature? What are the benefits of dynamic business process management to organizations? What is the role of hidden knowledge in dynamic business process management? Such questions are crucial in overcoming the limitations to implementing process management in organizations that are covered in the article, such as e.g. problems in communicating process maps and models due to their increasing complexity; traditional implementations of process management strengthening a culture of no responsibility; the loss of uncovered hidden knowledge due to the failure to integrate process management with knowledge management.

2. The process map

The article presents the results of research on the approach to business process modeling in three leading Polish construction companies: Budimex, Eiffage Polska Budownictwo, and Strabag. The research showcased herein was inspired by specific management activities undertaken almost contemporaneously in all three companies with the aim of making ground for the implementation of a workflow system (Budimex), preparing for the overhaul or improvement of an ERP system (Eiffage Polska Budownictwo), and implementing lean management (Strabag). The article was prepared on the basis of a series of interviews and workshops with the managers and employees of departments performing implementation activities, as well as by their analytical and implementation documentation.

2.1 The process map of a construction company

In accordance with the methodology of Business Process Redesign (BPR), process analysis in each of the companies began with the identification and creation of a process map aligned with the strategic direction of each company (Davenport & Short, 1990). During this stage of research, all of the expectations above responded to the following three questions:

- 1) Which processes comprise the main process?
- 2) What are the main support processes?
- 3) Who is responsible for the support processes within the organization?

Despite differences in nomenclature in regard to specific processes, the process maps of all of the companies were almost identical and were on the “n” level in accordance with the APQC model (APQC, 2015). The process map is presented in Figure 1.

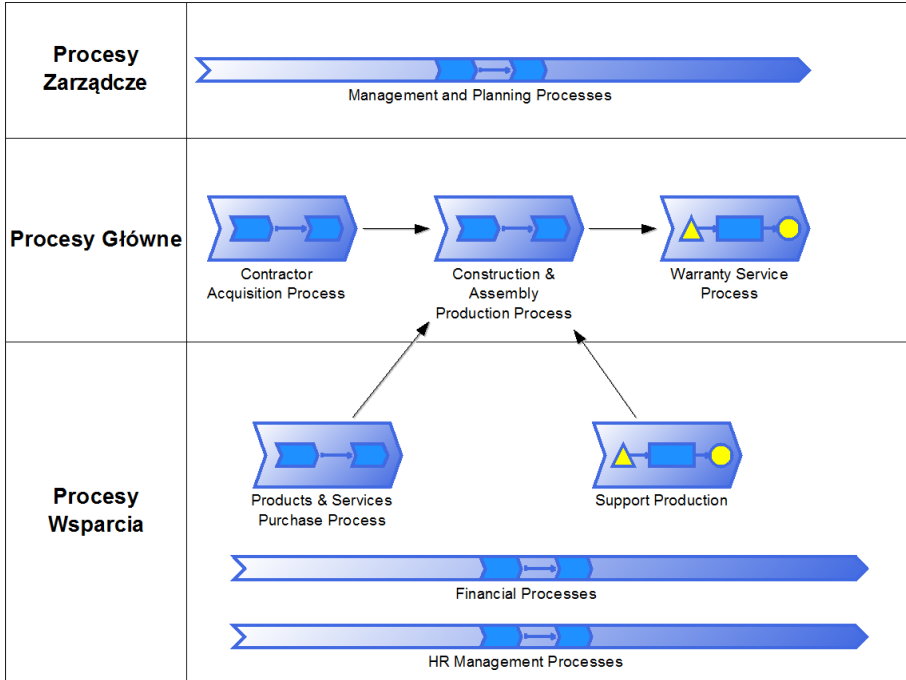


Figure 1. The standard process map for construction companies

Differences pertained to the detailed description of support processes (e.g. in Strabag “Infrastructure & Resource Management” was singled out as a specific support process). Alternatively, the handling of fundamental document groups or data on the level of the process map itself (e.g. in Eiffage Polska Budownictwo the process map included a schedule database, while in Strabag the onset of the Construction Process includes the preparation of a purchase schedule in cooperation with central purchases).

In all of companies above, the process of “Subcontractor Selection” figured as a fundamental element of the “Construction & Assembly Production” process, alongside the “Contractor Acquisition” process and the “Products & Services Purchase” process. For construction or development companies, this process functions as one of the most essential processes, one which often has a decisive role in whether a given project is profitable (or not) and whether the project is performed on time and its results are of appropriate quality. A wrong choice in selecting subcontractors could result in adverse economic conditions (adverse prices, payment terms), performance conditions (issues with schedules and quality), or organizational conditions (e.g. the loss of a subcontractor mid-project). At the same time, the “Subcontractor Selection” process is the process in which companies verify their knowledge

on the subcontractor and building materials market in the most direct manner available. For those reasons, this process has been selected for the subsequent, detailed stage of this research.

2.2 The “Selection of the Subcontractor of the site” Process Model (traditional)

The “Subcontractor Selection” process under evaluation comprises part of the main “Construction & Assembly Production” process. In some of the companies that took part in the research, parts of this process are also used in the “Contractor Acquisition” and “Products & Services Purchase” processes in order to perform a preliminary selection of subcontractors during the construction investment quotation stage.

During this stage of research, all of the companies responded to the following three questions:

- Is there a separate “Subcontractor Selection” process within the organization?
- What are the differences between the static “Subcontractor Selection” process presented in the diagram in Figure 2 & 3 and the process performed (in force) in the organization?
- Is the organization capable of accepting the dynamic model presented on Figure 4?

All of the companies that participated in the research confirmed that their “Subcontractor Selection” process is almost identical to one presented in the diagram from Figure 2 and 3. The main differences pertained to the level of depth (the number of steps), and the number of designed feedback loops crucial for the operations to be in concert with the interests of the organization.

One of the problems which all companies faced was the complex nature of the “Subcontractor Selection” process and the resulting problems with the supervision of its execution, as well as its computerization. In Budimex, the process was the simplest and comprised of a mere 13 steps and several feedback loops. In all of the companies, repeated attempts at its simplification resulted in the heated protests of individuals responsible for construction projects, who did not consent to be forced to operate within a workflow out of par with the conditions of the projects and market practices. Furthermore, these individuals contributed multiple thoughts and ideas pertaining to good practices, which should be included in the process itself, as well as in the ICT tools supporting its performance. In most cases, proposals for expanding the “Subcontractor Selection” process were formulated in a conditional manner: “according to circumstance...”, “sometimes I’d like to...”, “it would be good if...”, “sometimes I check whether...”. Another category were wishes regarding

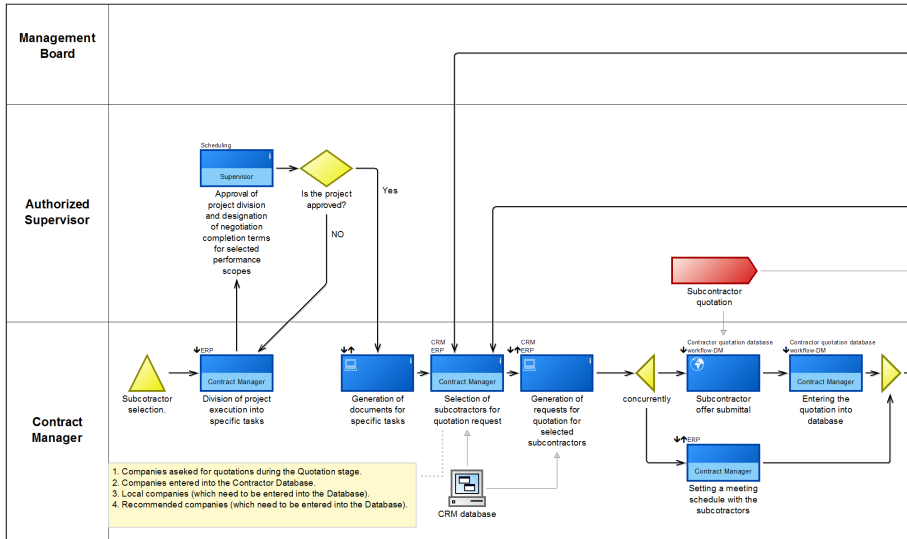


Figure 2. Diagram of the “Subcontractor Selection” static process (part 1)

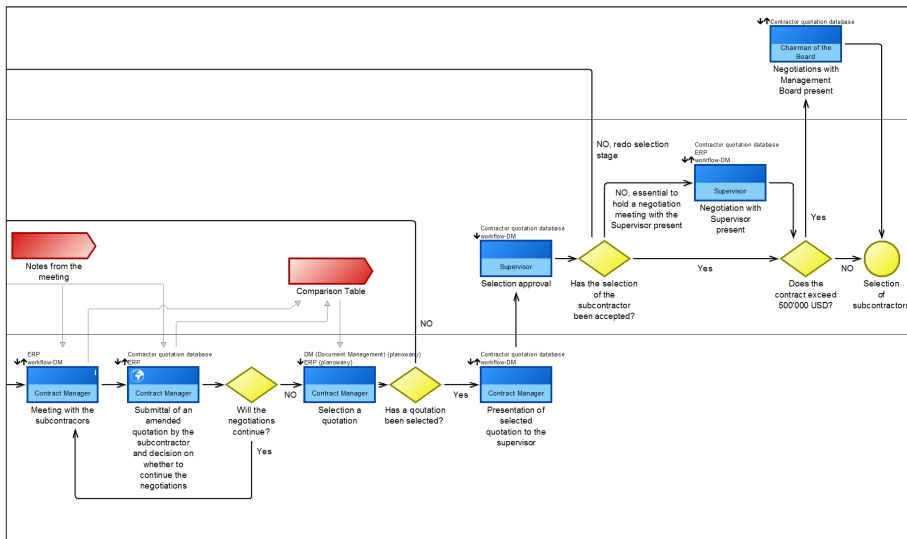


Figure 3. Diagram of the “Subcontractor Selection” static process (part 2)

data and information provided by the process. All research participants provided suggestions regarding the expansion of the scope of possible process evaluations. The individuals making the suggestions even accepted the ensuing larger time load associated with such an expansion. In all cases, the expectations were the result of specific situations stemming from the ongoing performance of contracts. For example, it was postulated that it should be possible to run a full comparative analysis of the “Subcontractor Selection” process for two subcontractors, should their respective quotations differ less than 1% in value, particularly when the cheaper subcontractor started work before the selection has been approved by the supervisors.

All research participants agreed that the further complication of the process in its current variation would make its computerization and management even harder. On the other hand, not introducing the postulated changes to the standard process model within the organization means that practical process performance deviates from the process model itself. Regrettably, knowledge on such operational deviations falls completely outside the reach of the company’s management. Hence it is not assessed nor accumulated with the aim of its further implementation within the organization. Because the further complication of the process model is unwanted, in the research it was suggested instead to change the aims, as well as the methods of its modeling. Because of the risks mentioned above involved with the static modeling of processes which are dynamic in nature, this suggestion has been accepted by all of the organizations taking part in the project. Dynamic process management becomes the standard which replaces BPM. Organizations should perhaps decide on a partial implementation of dynamic process management in those instances where the beneficiaries of the process expect or the competition forces the complete customization of the process to the conditions of a specific implementation, or even its individualization?

2.3 The “Subcontractor Selection” Process model (dynamic)

On the basis of the research, a “Subcontractor Selection” process model has been prepared with the use of dynamic elements compliant with the BPMN 2.0. notation standard. The “Subcontractor Selection” process has been modeled on the highest level of the process. The entire process (construction project, developer project) was divided into technologically unified (sector-specific) tasks. The subsequent selection of a subcontractor for each of those tasks is achieved within the “Subcontractor Selection” sub-process. It is initiated independently for each task. In Strabag, in the course of an analogous process, the division into scopes is already performed during the investment calculation stage (the “Contract Procurement” process), and later in the course

of the “Investment Performance” process the division into scopes is reassessed and verified on the basis of experience and the offers at hand.

The “Subcontractor Selection” process offers the contract manager the option of performing the following 4 actions:

- Subcontractor quotation management,
- Comparison table analysis and post-meeting notes analysis,
- Consultations within the organization,
- Selecting the subcontractor(s) for a given task.

The aforementioned actions can be performed multiple times and repeated in a sequence resulting from the current state of construction, the actions of the designer, the investor, the subcontractors, the public administration bodies, as well as the type of construction, the technology (included in the project or substitute), the completion schedule, and other unforeseeable factors.

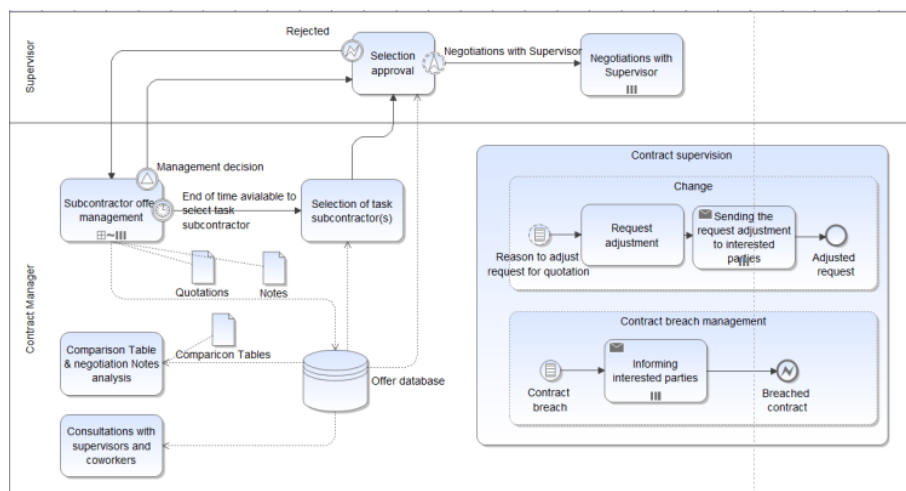


Figure 4. Diagram of the “Subcontractor selection” process in the dynamic variant

At the express request of the practitioners, the process has been supplemented with two tasks resulting from events independent from the decisions of the contract manager:

- Management of adjustments to the requests for quotation (e.g. due to discovered discrepancies in the documentation, shifting schedules, investor decisions.)
- Management of a breached contract (e.g. due to not receiving an advance payment on time, the contract being canceled by the ordering party).

The modeled process is performed on the basis of standard documents and a quotation database included in the diagram. In the case of the companies included in the research, the documents had different graphical templates and required different software, but their functions were nonetheless identical.

In the proposed process model, the process performer is given the full freedom to make decisions pertaining to his or her work. The process performer he or herself will decide on the sequence and the eventual need to repeat specific tasks, as well as the specific moment of selecting a subcontractor and submitting the decision for approval to authorized individuals (e.g. the supervisor and/or responsible individuals in central purchases). In effect, the proposed process model has multiple qualities, which thus far were regarded as belonging to the domain of Case Management (Belaychuk, 2011). Knowledge of the full context of the performed process is available to be assessed during and after the process performance itself. This has been achieved without burdening the process with additional decisions or feedback loops.

2.4 The “Subcontractor Quotation Management” Process model

The “Subcontractor Quotation Management” process is a fundamental sub-process of the “Subcontractor Selection” process. All companies participating in this stage of research were tasked with supplementing their process workflows with their used documents and fundamental data.

Within the standard model prepared in the course of research and depicted in Figure 5, the process is comprised of 5 tasks. In the case of Strabag, however, the process was divided into not 5, but a total of 8 tasks. In comparison with the process selected as the standard model (Figure 6), the Strabag process also accounted for:

- 1) Receiving preliminary quotations (quotations, e-mails).
- 2) Technical and business meetings, procurement of binding quotations (quotations and protocols).
- 3) Selection of finalists.
- 4) Business negotiations.

As in the previous process, tasks are performed according to the decisions of the process performer. He or she decides on the number of times subcontractor candidates will be selected, the number of adjustments to requests for quotations, as well as the number of meetings required to select a subcontractor for a specific task. When we label the subsequent tasks of this process as:

- A – Selection of subcontractors,
- B – Submission of a request for quotation to a selected subcontractor,
- C – Submitting the quotation,

D – Meeting with the subcontractor,
 E – Assessment of the quotation,
 and the passage from one task to another with “→”, we can present the basic performance of the process as:
 A → B → C → D → E

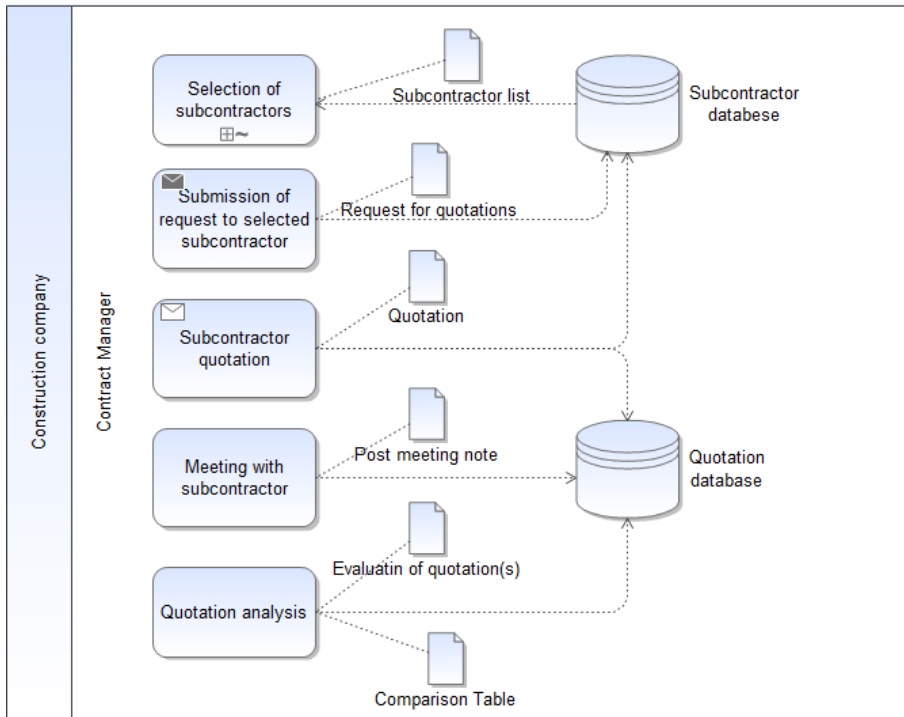


Figure 5. The “Subcontractor Quotation Management” process

The model presented in this article fulfills the requirements set by Strabag by imposing the requirement of repeating the „Subcontractor quotation” and „Meeting with subcontractor” tasks twice for all selected subcontractors and participants of the final proceedings. In such a case, we can present the process as:

A → B → C → D → C → D → E

Of course, performances of the process are possible in which account for multiple negotiations with the subcontractors and e.g. allow for changes to requests for quotations, as well as submitting quotations a multiple number of times within a single process. In such a case, the process within the BPMS system looks as follows:

A → B → C → D → D → B → C → D → E → B → C → D → D → E

Of course, each task is accompanied with data on its duration, as well as data on the submitted quotations or negotiated terms and conditions of implementation.

The description of an ongoing (or completed) process will complicate further if we take into account the subsequent management of quotations from multiple subcontractors. Nevertheless, the simplicity and the flexibility of the description, as well as the transparency with which one can analyze the work of contract managers or teams leading sales negotiations resulted in the delight of both process performers and their supervisors.

The sole limitation imposed by the methodology of dynamic BPM on the contract manager is the requirement of documenting the performed tasks on an ongoing basis by preparing requests for quotations in the system, entering quotations and post-meeting notes into databases (Szelągowski, 2014). The role of the IT system is the presentation of data entered into the system and their comparative analysis via e.g. the creation of comparison tables and making data available to other authorized employees within the organization. It is also possible to define rules according to which the system will automatically direct the attention of its users to specific data configurations, such as an exceptionally low price (e.g. at least 30% lower than the competition), a quotation submitted by a subcontractor with a negative qualification, or exceeding the time of subcontractor selection by more than 5 days.

2.5 The “Selection of Subcontractor Candidates” Process model

In all of the companies which participated in the research the “Selection of subcontractor candidates” process is performed in cooperation with the central unit responsible for sales. A list of potential subcontractors is determined – preliminary during the quotation stage and final during the execution stage. In the case of especially large and fundamental scopes of deliveries and performed works (e.g. deliveries of concrete, bitumen, or steel), the process is handled not by construction, but by central purchases, usually on the basis of long-term framework contracts.

Its aim is the selection of candidates for subcontractors among companies with prior work experience (qualified) and the ongoing search for new subcontractors among companies recommended by the Investor, subcontractors operating on the local market (small and medium-sized enterprises in particular), large global companies entering a given market. When labeling as before the subsequent tasks of this process as follows:

- A – Analysis of ordering party requirements,
- B – Analysis of the subcontractor database,
- C – Search for new subcontractors,

D – Consultations with supervisors and coworkers,
 E – Creation .update of list of subcontractors asked for quotations,
 we can describe the common “authoritary” variant of the process as
 D → E

The standard variant in the companies which participated in the research looked as follows:

A → B → C → D → E or A → B → C → D → C → D → E or

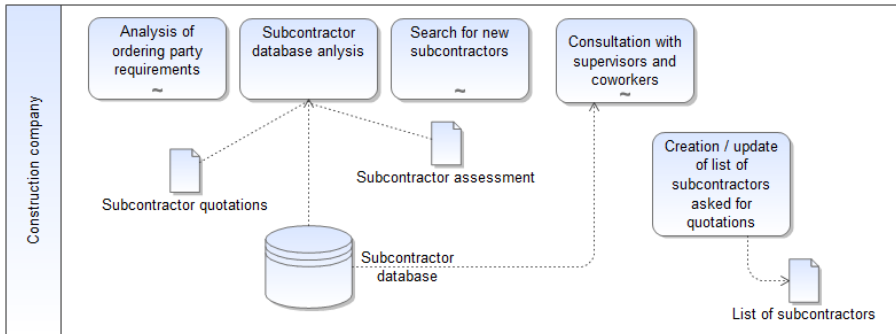


Figure 6. The “Selection of subcontractor candidates” process

3. Conclusions and future works

Process identification projects are currently underway in all of the organizations in question. The two main goals of implementation are:

- 1) Raising the effectiveness of business process performance.
- 2) Allowing for the collection and management of knowledge on the business processes performed within the organization.

The first goal of implementation is self-explanatory. The possibility of achieving the second goal is the indirect result of a change in approach to process modeling, which was formulated in the course of this research project. Its main goal is no longer the detailed (as exact as possible) reflection of the actual process performance (control flow). It is no longer required for the modeled process to prohibit actions which deviate from the „ideal” standard process. In the construction sector, where each investment is unique, there is no place for a single „ideal” process map. Hence the modeled standard process is meant to support its performers, providing them with the option of dynamically shaping their work according to well-proven best practices resulting from specific case studies. The proposed solution fulfills the requirements above by making available, within a business process modeled in accordance with BPMN, functionality which was thus far associated with

Case Management systems. Further works on the subject should determine whether this approach offers the practical combination of both concepts and their tools. (Knudson, 2014; Silver, 2014; Knudson, 2015; Palmer & Sanchez, 2015).

At the same time, it is essential to consider as one of the main goals of process modeling the collection, verification, and rapid dissemination within the organization. In addition, the knowledge on particular subcontractors and their quotations, the subsequent work on ongoing or completed projects, as well as well-coordinated knowledge on available materials and solutions., their prices, availability, failure rates in the warranty period (Venkateswaran & Aundhe, 2013).

As demonstrated in the article, the implementation of a BPMS system A.D. 2015 can enable the day-to-day collection and use of knowledge on process performances and their results. In such analyses, there is no need to use specialized software from the field of process discovery. By implementing BPMS (of course without forgetting about its integration with the existing ERP system) and having access to full data on the context of a given process performance in the event logs, we can replay, analyze, and compare the actual performance of a dynamically-modeled process with a standard process “as of today” (Process Mining Manifesto, 2012). It will suffice if BPMS analyses offer the possibility of:

- assessing of completed (ex-post) and ongoing (on line) single processes or performing comparative analysis on groups of processes,
- assessing changes (of values, and trends) to fundamental codified knowledge elements in relation to performed processes.

For all intents and purposes, this means that for construction companies, process mining is no longer a „novelty” from literature. Nor is it a methodology or technology which would require additional decisions and additional implementation. Process mining is a natural, expected element of business process management in accordance with the concept of dynamic BPM. Questions which will need to be answered in the further course of research are: How to effectively make use of exploration process techniques (process mining) to obtain and analyze practical knowledge? How to verify such uncovered hidden knowledge on a daily basis? And how to use such knowledge to gain a competitive advantage?

For the time being, none of the companies which took part in the research had formalized knowledge management processes. For example, in Strabag a formal exchange of information between construction projects takes place only via workshops based on case studies organized by the central departments of the organization. Of course, in all of the companies, there are informal processes of knowledge sharing at hand, which are based

on informal communities of practices. However, in order to accelerate knowledge management processes and achieve full efficiency, it is crucial to establish a strong connection between the performed processes and knowledge management processes within the organization. This requires further changes in the approach to process modeling in the near future. It is crucial to combine within one model elements of process description (BPM, or rather – dynamic BPM) and knowledge management (KM), as well as to integrate operational processes and their resulting knowledge management processes within the general process model of the organization (Remus & Schub, 2003). From this perspective, future articles should touch upon the subject of using process mining as a natural connective point between the methodologies of BPM (rather dynamic BPM) and Knowledge Management.

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