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Risk management

ANALYSIS OF THE COMPLEXITY OF THE OPERATIONAL PROJECT FROM THE ASPECT OF MANAGEMENT AND MINIMUM RISK OF PROJECT

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ABSTRACT

Demolition works can be considered as a part of civil works within projects performed in the process chemical industry. Risk identification is one of the first steps of project and risk management. Although it is very important in terms of practical engineering and designing also for the improvement of existing risk methodologies, it is evident that demolition projects in chemical industry are not a common theme at the available scientific research literature. This study is focused on deeper understanding of risk assessment in the early phases of project life, project success and uncertainties. Generic structural method is used as a tool for mapping the design phase important for risks defining. Results of the research suggest that selection of the appropriate demolition technique tributary costs also that demolition risks are not absolutely covered with turnkey type of contracts. Likewise, during the process of chemical plants demolition, since they were out of working cycle for long period of time, main expecting environmental impacts are active through the residual chemicals gaped in the plant. Noise and vibration have low intensity and represent more subject to the working environment. Waste solid material has potential as secondary raw material.

Keywords: risks, base oils, demolition, project complexity, project success.

AIMS AND BACKGROUND

Early identification of risks in demolition projects in chemical industry is the first step in risk management[1]. Impact on the environment in demolition projects in chemical industry is integral part of risk assesment. Essential for improving project success is good risk management. This study emphasises a need for deeper risk analysis in specific demolition projects.

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Basically, any demolition, considered as reverse activity of construction works, involves many activities such as dismantling, razing, destroying or wrecking any building or structure as well waste management. Risk assessment is a key requirement to undertaken demolition project so risk identification and associated cost estimation must be defined at the early stages of the project life cycle. Appropriate planning and demolition technique need to be based on thorough risk assessment study before the work commences. In such projects, description of possible significant impacts of the project on the environment is important not only from the legislation point of view but as integral part of risk assessment.

Every demolition work site has unique characteristics so technique, method, plan and respond to the risks must address the site particular needs. From the decision to execution, project goes through several phases[2]. Extensive health and safety plan should be given at the pre-tendering stage, prepared by demolition contractor. Identification includes determination of the probability, severity and exposure of demolition risks[3].

According to available literature, less number of journal articles describes demolition process of facilities in chemical industry[4] and more literature citations refer to civil industry demolition[5–8]. There are very few examples on implemented demolition projects for chemical plants. In the field of designing, project management and risk management practically there is no example of the complexity analysis, selection of appropriate risk assessment methodology or proven existing demolition techniques. This study represents the results of conducted demolition project in chemical industry. As a rare example it is kind of platform on the basis of which can be carry out further analysis of the complexity of such projects, demolition techniques and risk assessment not only for the selected method of demolition but the selected type of contract.

PROCESS DESCRIPTION AND DEMOLITION PHASES

The technological process of base oil production consists of several processing functional units and produces semi products removing heavy compounds from oils by converting and separation of the residue[9]. These semi-products are further planned to be updated trough other processes to high quality finish products – motor and industrial oils[10].

Solvent extraction process was effective but expensive and non-ecological, so unpopular and outdated. Chemical-technological facility (Fig. 1) that is beyond the working cycle for years, is envisaged for complete disassembly in order to provide a needed space for the construction of new and modern processing plants. Lacked with adequate detail technical documentation needed to describe the history of the plant (design project, production reports, quantities and kinds of used chemicals, information about points filled in with flammable and toxic chemicals and quantities of it, etc.) it was challenge to conduct to the final success. It was assumed that plant was fed to the content of 66% sulphuric acid and 34% different hydrocarbons. Expected waste materials were caustic soda, hydrocarbons, sulfuric acid, alcohols, gudron, different kinds of metals, and plastics. Process of removal and dismantling of the existing plants included dismantling of mechanical equipment and piping, electrical equipment, building construction and steel structures. Such activities imply proper planning and good management. Since demolition is to be maintained on the chemical plants, there is always the risk from unexpected spills, releases into the atmosphere and explosions. In relation with environmental legislations, during the execution of the demolition project, there are several issues important for risk assessment: pollution of water, air and soil, noise and vibration and waste.

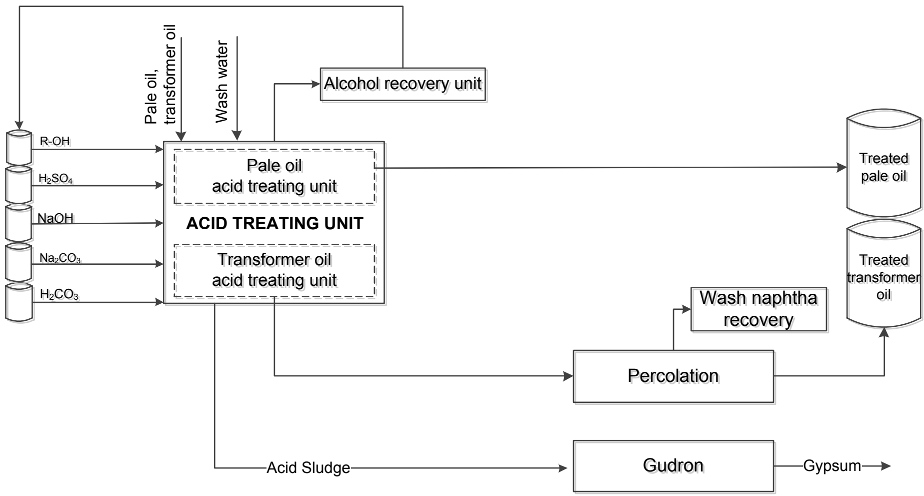

Fig. 1. Acid treatment plant

RISK ASSESSMENT

Risk assessment is the overal process of risk identification, risk analysis and risk evaluation[1]. Demolition works are among the most hazardous operation and is responsible for more deaths and major injuries than any other activity[7]. HSE risks are mainly related to unplanned collapse of the structure. Having in mind kind of fluids used in the process of solvent extraction and the fact that the plant was out of the duty cycle for many years, a very detailed analysis of the residual levels of hazardous chemicals should also be studied. Work of this kind need to be undertaken only by competent and suitably experienced contractors and personnel in safely and efficient manner. Action plan is scheduled to be done at the stage before the selection of the contractor, practically on kick-off meeting.

The most common risks of engineering projects performance are mapped into several categories: related to the external environment, project organisation and high level management performance[11]. Demolition projects of chemical plants do not have elemets which are connected with external environment (meaning market, prices, competition, etc.). Having in mind that chemical industry imply hazardous gases, liquid and flame substances, risk assessment seems to be main activity within demolition project. If company or investor has strict safety procedures for any activity like production, construction, procurement, investment etc. it is prospected that all risks are covered and no risk is expected to appear. Most used demolition method is generic structural demolition[2].

Generally accepted risk classification and most used risk categorisation type for construction projects is consistent to risk sources, but varies according to the need in the specific type of the projects[12]. In this case because single project is part of the bigger schedule and because the vital part of the facilities are still in operation, risk assessment is very important. According to literature[2], the choice of demolition technique is carried out in the tendering (pre-tendering) stage is based on; client specifications, location, accessibility, shape and size of the structure, stability of the structure, presence of hazardous materials, time constraint, degree of confinement, transportation consideration, extent of demolition, structural engineer approval, financial constraints, recycling consideration, environmental considerations, health and safety.

There are a number of technical solutions on the basis of which demolition can be carrying out (manually, using machnices, chemicals or demolition by high pressure water jetting) and methods of generic types of structural demolition (progressive demolition; deliberate collapse mechanisms and deliberate removal of elements). Works of dismantling and demolition of this kind are performed using machines technique (hydraulic attacments, mechanical attachments, cutting by drilling and sawing). Progressive removal technique is carried out under the structure controle to maintain the stability of the rest of structure and to avoid a collapse the whole or a part of structure. Risk assessment should begin along with a company decision to start a project of dismantling and demolition and developed by demolition contractor[13]. In practice, the decision on the choice of demolition techniques is generally based on factors such as technical aspects and economic considerations. Typically, the selection process is performed in an unstructured intuitive manner with significant reliance on the experience, skill, knowledge, or judgment of the demolition engineer.

Besides time constraints, cost estimation is second big element of project success therefore an effect on the risk of the project. It can be calculated with preliminary or detailed method. In practice pricing of demolition work generally involves preliminary estimates, based on the cubic capacity of the structure in line with the types of objects and their construction. Main elements of the cost estimation include: site overhead costs, decommissioning costs, soft stripping costs, waste disposal costs, structure demolition costs, general overhead costs. Although preliminary method calculation is preferable and the most commonly used disadvantage of such approach is the lack of detail and potential overpayment real price of the works. In case of preliminary cost calculation, only costs for the selected demolition technique are included but not for all available alternative demolition techniques[13].

According to industrial practice, risk is perceive on the basis of previous experience in these and similar projects and identification of risks conduct based on existing risk catalogs. Often in practice main demolition techniques are not perceived by investors in early phases of project life cycle but bidders demonstrate some of them and according to the bid requirements. In case of turnkey contract risks of the unsuccessful project completion is seen as transferred to a contractor who is required to complete work safely, on time, within defined budget and quality.

Investor mainly selects the least expensive one that deems most appropriate and most acceptable for him. But in project like this company rarely have enough experience to predict specific risks and investor conclude turnkey contracts to try to transfer all the risks on the contractor side. Since the determination of the method of demolition and cost estimates are closely related, if the contractor independently determines and selects the method of demolition investor probably not perceived real costs of investment. Accordingly, investor will not be able to predict possible delays and misleading final quality of the site works, considering that only part of a technological process will be demolished and parts of existing pipe bridges and installations will be used further for reconstruction and construction of the new plants.

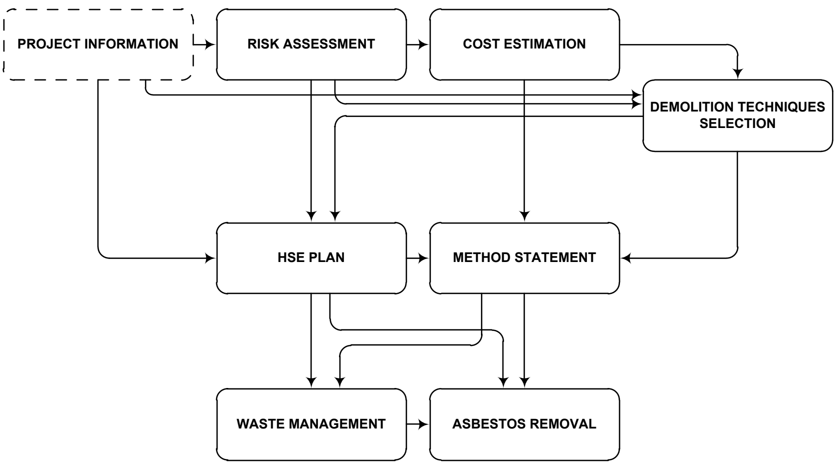

Fig. 2. Interrelation of project information and demolition risk assessment[13]

On the other side, according to available scientific literature, for risk assessment completion and definig all finances and constraints it is important to determine project complexity through design data, postulates of the profession, environmental and site data[14]. Project complexity will affect HSE plan, demolition technique and cost estimation as well. Detailed cost estimation will influence method statement which along with HSE plan indirectly affecting waste management and asbestos removal.

Risk assessment will reflect directly on HSE plan and selection of suitable demolition technique, method statement and cost estimation.

RESULTS AND DISCUSSION

This project was executed within the planned time of 54 days and conducted with two incidents. More or less one can conclude that project is sucess because time schedule was achieved, budget also and minimal damage was reached. Recorded are the two accidents by contractors and subcontractors: breaking underground power cable at the plant for acid treatmant of oils, and breaking of the fence pillar of open warehouse of adjacent plant that is outside the bater limit of the project. Based on that it can be concluded possibly there was a failure in the organisation performing these works. First sign that structural complexity concerning organisational complexity as well tecnical, even though the project is a turnkey, is important issue and need to be discussed, preferably in the early phases of the project[15–17]. Although, due to the type of contract risk and consequences paied the contractor.

Demolition of old plants out of duty cycle for more than 20 years is first project and practically introductory phase of bigger project of modernisation seen as preparatory works. As in other operational engineering and construction projects, from the point of view of project management there are two main activities as source of uncertainties: time and budget, because demolition is just one phase of one big project. Possibly, in dependence of previous experience of the investor or project manager, turnkey contract may imply most risks deriving from demolition process as single project, but not obligatory and all consequential risks. The key question is whether it is a linear approach arising from the industrial standards good enough? Linear prediction methods are not seems effective enough, because they lead the process in one way unlike generic approach method which identify the risk assessment in the early phases of project and gives better results since it enables consideration of problems early and more effective decision-making and project management and project risks (Fig. 3).

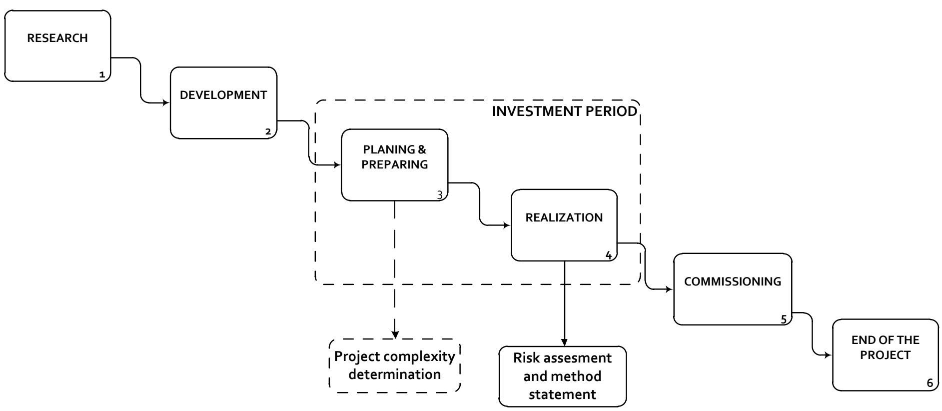

Fig. 3. Defining and estimation of risk in the project life cycle

Project complexity considers structural complexity and uncertainty[15]. In projects like this, challenging but not too large, organisational comlexity is not an big issue especially because it is conducted under turnkey contract which means that contractor bares the risks. In order to perform a successful and efficient management, it is necessary to know and understand tecnical complexity and the nature and type of process in order to define the arrising risks, make adjustments and take adequate measures to reduce uncertainty. So project complexity has to be defined in planning and preparing phase of the project life cycle[17]. Risk assessment needs to be developed and recognised in the early project phases, during pre-tendering stage which means that investor has to have clear image of potential risks[18]. Project sucess is not only in good project management driving project in the frame of time schedules and budget but in long-term sucess acheiving strategic goals.

The concept of technology in organisational sciences usually involves the execution of tasks, but it covers far wider definition which has not reached a consensus as highlighted in the literature. In this sense, the concept of technology as a multidimensional concept is within the idea of complexity in the domain of differentiation (the number and diversity of inputs and/or outputs, activities, tasks in order to obtain the final product, specialty), interdependence (between tasks, teams, different technologies, etc.) as well as the instability of assumptions based on which the given tasks are set[15,19].

Table 1. Chemical process used in base oils production

Plant I Gudron	Plant II Acid treating unit	Plant III Percolation
Caustic soda	sulphuric acid	bauxite
Sludge (consisting of 66% sulphuric of acid and 34% organic matter)	caustic soda	special gasoline
Hydrocarbons	alcohol	
Oily water	sulphonate solution and soap	

Regarding used technology described previously, expected residual chemicals are main source of risks. To avoid spilling and water or soil contamination as well human injuries first step is planning removal of residual chemicals, and rinsing and flushing pipelines and equipment (filters, percolators, vessels, exchangers, heaters, pumps, etc.). Having in mind specific information (Table 1) it has to be identified method for proper removal and generate good plan for execution of it. Besides chemicals, second important issue is isolation material for pipes and equipment (glass wool) and potential sources of asbestos. If asbestos exists it needs to be removed with measures to eliminate the risk factor (no entry persons, use of respirators, protective clothing, and disposal of asbestos in specially marked boxes or containers, transfer to a special destruction). Glass wool has no harmful effect on human health, whether in handling human staff should use protective equipment to avoid physical injury. Third important issue concerning risks is raw material which could be recyclable (Table 2).

Table 2. Recyclable waste materials

Plant I Gudron	Plant II Acid treating unit	Plant III Percolation	Recycable
Iron (Fe)	Iron (Fe)	Iron (Fe)	yes
Steel	Steel	Steel	yes
Aluminum (Al)	Aluminum (Al)	Aluminum (Al)	yes
Copper (Cu)	Copper (Cu)	Copper (Cu)	yes
Isolation	Isolation	Isolation	
Construction shot	Construction shot	Construction shot	

These materials originate from dismantled and removed equipment, civil structures and mostly are recyclable. Within the project it is necessary to dispose the waste on labeled locations and deal with it in accordance with applicable regulations and the type of waste material. Since most of the expected materials are metals they could be used as secondary raw materials. Only asbestos needs specially treated.

Table 3. Assessment of the impact on the environment

Environmental aspect	Results
Gas pollution	no
Water and soil contamination	no
Noise and vibration	yes
Ionizing and ionizing radiation	no
Waste	yes

Accidents, by the European Union definition, are a sudden occurrence of major pollutants emissions, fire or explosion as a result of unplanned events within a particular industrial activity that occurs within or outside the industry, including one or more of the chemicals. Defining potential hazardous situation is the initial step in the risk analysis of the projects on the environment (Table 3). The risk of hazard in this project exists, but is not related to the technological process that previously took place at the plant, but is related with the work injury caused by careless handling and hidden 'pockets' in the plant, where it is possible that there was a retention of residual amounts of dangerous materials because it is the entire facility out of use for so many years. Bearing in mind the age of the equipment and the applied protective measures, analyses hazardous situations are assessed as a medium probability of accidents (consequences may occur once in 5–10 years). Research presents that, according to the literature findings and to Generic structural method, main activities are important to be done at planning and preparing stage of the project life cycle but in practice it is different. Activities concerning HSE in this project were conducted later and most important activities like project complexity determination and selection of the most suitable demolition technique that influences main possible risks are not conducted at all but specialised contractor was engaged to maintain it (Table 4).

Table 4. Realised activities and perspective of uncertainty and risks

Expected activity	Realised activity	Uncer-tainty	Discription
Project complexity determination	–	high	time, cost and budget overruns
Risk assessment			
HSE	+	small	human factor most dominant
Other	–	high	mostly human injuries
Selection of deomolition technique	–	high	inadequately analysed opportunities
Method statement	+	moderate	inadequately analysed opportunities
Cost estimation	+	moderate	budget overruns, paid too much

Since the plants were out of work for long time and main requirement to be winner of the bid was conditioned by experience in similar jobs, it seems that environmental risks were minimised, but in terms of long-term risks and total project success situation is not so simple. In terms of HSE risks as well project management project was conducted and finished successfully and budget for the project was not exceeded. Since the project was executed under turnkey contract, company catalog of risks is not amended. But, in the long terms reaching long-term success in some cases, companies do not take into account or consider risks that are below defined minimum price constraints to update catalog of risks with real data. Secondly, without detailed cost estimation in the bigger picture and without establishing demolition techniques, preliminary cost estimation approach will condition that market offer and quality of bidders form the quality and cost of the project since the criteria is set only in an intuitive way. Such business policy provides a platform for uncertainty arising from the works that are not clearly controlled and properly managed as may not necessarily condition failure of a project but it will condition a hidden future uncertainty if one's, conditionally speaking, smaller project is at the same time sub-project and one element of bigger project. Most of these HSE activities are included in the PMBoK standards (Project Management Book of Knowledge) standards and norms, and every large chemical industry has them and respected.

Just after accepting a job and contract signing, during the kick-off meeting contractor is obliged to get acquainted with the standard procedures of the company, to present the detail HSE plan based on the nature of the project and conducts complete HSE procedures until the end of the project. In other words, in this particular project, according to economic reasons, consequently, selected demolition technique was based on accessible mechanisation of selected contractor and demolition technique was designated with the principal order of disassembly conditioned by the technological requirements of residual fluid and route of underground installations. Bill of quantities was completed based on the amount of material that is designed to remove. Used machinery were: mechanical (hydraulic) cutters for sheet metal, large hydraulic hand hammers used to break concrete, excavators for loading debris and transport trucks. To accept sheet metal and equipment were used hydraulic shears. Work performed around 30 people, in groups according to the type of material.

Thus was not considered the most appropriate techniques and methods of demolition nor calculation for all available possible technical solutions or alternatives. However, under the commercial negotiations was selected currently the lowest available price of the works in this market. Principal order of disassembly was conditioned by the technological requirements of residual fluids and route of underground installations for the part of the installations, and for other part were used design projects, plats connected with existing facilities that are in operation (mostly utilities).

Meaning if the project manager does not have enough experience and/or do not estimates complexity of the project in the early phase of the project life cycle, one will not be in a position to propose potential problems, because he will not be able to perceive of them. Possibly he will manage project more intuitively but with total control. In the case of large and complex organisational structure, a number of rigid and complex procedures of communication, management and decision-making, certain types of problems that arise from complexity and type of project will recognise only if and when occur. That means that uncertainty plays role on the upper levels because of causal and bidirectional connection between different phases and smaller projects which are elements constituting large-scale projects.

CONCLUSIONS

Risk assessment and management on the project of demolition, dismantling and removal the chemical plants has few dimensions: assessment of risks with occupational safety and environmental protection (HSE) as well project performance risks observing success in long terms. It can be concluded that large companies by avoiding assessment of project complexity that provides transparency in the assessment of risk are ready to pay more than the real cost of the project.

The goal of this research was to determine to what degree project classification and complexity impacts the type of risk events occurring in engineering projects. This research explored the impact of technical complexity to the critical insight in identification and defining appropriate risk management approach to projects.

To conduct risk assessment and adequate risk management it is indispensable to introspect project complexity. Causal and two-way relationship between the elements and disciplines of the project is an important issue for each especially in large projects. Whether the company can withstand more or less cost of execution and lead project performance through turnkey contract, and milestone type of payment to contractor, there is no guarantee that all risks and consequences are covered. In addition to turnkey contract and tendencies that all risk is transferred to the side of the contractor, very important thing is to enable even the most experienced lawyers to consider clearly potential problems and adapt the standard contracts better, in terms of protecting the interests of the company on as many levels. Somehow it is well known practice that in engineering companies technical staff considers contracts which is also a source of uncertainty.

To complete strategy of the company, and reach upper goals, only by assembling small parts of the mosaic made with all projects in the portfolio. Meeting the objectives within a defined time, scope and budget are often synonymous with the success of the project. But these seem as not ideal measures of success. Measuring success it is more precisely to observe the period of time, because if it appears today that one the project is successful, it does not mean that tomorrow perspective will be the same, especially in cases of large projects which consists obligatory small ones.

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