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Safety and management of the subcontracting of maintenance work in a petrochemical plant

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Maintenance is a key factor in improving the performance of petrochemical industry. The maintenance of a petrochemical plant is complex from an organisational point of view since subcontracting is becoming the norm. In this paper we present a model of subcontracting maintenance work with the aim of reducing the occupational accident rate of subcontractors. This model is based on the increase of procedures and controls. We will see the short term results of this model on the occupational accident rate of subcontractors and the risks that it poses to the system.

1. Introduction

The goal of maintenance in a petrochemical plant is to ensure the availability and reliability of equipments and facilities. Thus, maintenance plays an important part in improving the performance of this industry.
The maintenance of a petrochemical plant is complex from a technical point of view due to the processes used and from an organisational point of view since subcontracting maintenance work is common practice.
Subcontracting has steadily increased since the middle of the 70s for obvious economic reasons: allowing clients to refocus their investments on their core business
Risky industries such as nuclear or chemical industries subcontract the execution of their maintenance work for several years.
Such subcontracting has a potentially negative impact on subcontractors' safety demonstrated by the fact that subcontractors often have an occupational accident rate higher than in-plant staff.
In this paper, we first present the theoretical framework of the link between safety and subcontracting. We then analyse the reasons that motivate clients to subcontracting. We present the model of management of subcontracting maintenance work in a petrochemical plant whose aim is to reduce occupational accident rate of subcontractors. The occupational accident rate of subcontractors is more than twice higher than the one of in plant staff, and it becomes unacceptable for this petrochemical plant. We then discuss the limits of the model set up, which is mainly based on the increase of procedures to be followed by subcontractors.
We illustrate the theory using the example of one specific petrochemical plant but whose characteristics are generic and representative of the practice of subcontracting maintenance work in the petrochemical industry.

2. Theoretical framework

There are two kinds of literature which treat subcontracting. On the one hand the economic literature that promotes subcontracting in its ability to improve companies' competitiveness; and on the other hand the ergonomic and sociological literature takes a largely negative view of the use of subcontracting and the impact it has on safety.

The economic literature is the most important (Douglas, 2005) (Power, 2006) (Corbett, 2004) (Francastel, 2005) and discuss about the strategies of subcontracting and how to contract.

Ergonomic and sociological literatures are mainly focused on the impact related to the social status of subcontractors and their occupational accident rate. This literature is mainly a francophone one.

For example, in France Annie Thébaud Mony (Thébaud Mony, 2001) explains that the main clients have reduced their occupational accident rate by subcontracting their risks. She gives the example of radiation risks in nuclear power plants in France, of which 80% are borne by maintenance subcontractors. She explains that the intensification of work is subcontracted (automotive, nuclear outage) and flexibility has increased the time constraints.

Mayhew (Mayhew & al, 1997) in Australia shows that subcontractors are involved in twice as many accidents / incidents as internal staff. She explains this by the specific risks at work and exposure to hazards. These risks are, she says, exacerbated by the intensification of work.

In France there are no national statistics on the occupational accident rate of subcontractors. A study by AFIM French Maintenance Engineers' Association, in 2003 (Afim 2003) shows that subcontractors have more occupational accidents than internal staff.

3. A model of subcontracting for ongoing maintenance work

There are three kind of maintenance work: (i) ongoing or daily maintenance work which is executed without an outage of the installation but where the equipment is isolated, (ii) maintenance with an outage of the installation, (iii) modification or construction of new units.

In our study, we focus on the first one, the ongoing maintenance.

3.1 Why subcontracting maintenance work

Subcontracting has evolved considerably over the past two decades; it has grown from subcontracting trades without value added to the clients, such as catering, transport or green spaces, to subcontracting of direct business supports such as maintenance of production units.

In the example we study, subcontracting represents 50% of the hours worked on the plant which is nearly 2.5 million hours of work per year.

The execution of the maintenance work is subcontracted for a variety of reasons, among which are:

- a business strategy based on the refocusing on the core business,
- competent and specialised personnel staff in each of the maintenance trades,
- less expensive personnel costs especially for less value-added trades

- a need for flexibility and rationality with personnel present on the installation only when needed

3.2 Risks linked with subcontracting

The practice of subcontracting can also cause potential problems particularly with regards to the safety of subcontractors but also increases the dependency of the client on its subcontractors and a loss of in-house competencies for the client.

Regarding safety, we've seen that subcontractors often have an occupational accident rate higher than internal staff, and it is the case in the plant where we conducted thos study.

In this plant, subcontractors' safety results have an impact on the performance of the petrochemical plant safety since these results are included in the overall safety results of the plant. the plant had the worst group safety results regarding subcontractors. A significant effort has been made to reduce occupational accidents of subcontractors. The plant set up a reorganization of its subcontracting relationships of ongoing maintenance to decrease the numbers of accidents. The following text investigates, how this action has been handled, its results, which model underlies this action, and the lessons to be learnt about the side-effects of this action.

3.3 The action set-up: a zero accident policy

The aim of the reorganisation set up is to reduce the occupational accident rate of subcontractors. The watchword is that each accident can be avoided. This action initiated by the plant direction is managed by the maintenance department. The maintenance department is recognised as the main client of subcontractors and coordinates the maintenance work executed by subcontractors.

This action is based on three points:

3.3.1 Development of subcontractors' loyalty

The client chooses subcontractors that are technically highly recognised for their technical speciality.

The maintenance subcontractors' loyalty is fostered in 4 ways:

- longer term contracts : from 3 to 5 years
- contracts with a fixed price to propose a large portfolio of interventions
- a wish to have stabilised people on the fixed-price contract, in order to improve subcontractors' knowledge of the plant
- the client takes into account emergencies in the payment of the sub-contracting companies, in order to minimize in-plant emergency requests and to compensate the subcontractors for their flexibility

3.3.2 A more rigid framework in the preparation and execution of the sub-contracted work

An increase and a hardening of the intervention procedures and constraints are added to the reorganisation of the contracts.

A process is set up to formalize all the stages of subcontracted maintenance work: the defaults or anomalies detected by the plant operators, the joint preparation (client and subcontractor) of the intervention, the interventions by the subcontracting company and the reception of the work.

The communication between the client and the subcontractor is formalized: no intervention is supposed to take place without a joint visit of the work site and subcontractors must attend the daily meeting of each sector of the installation where they will work.
An example of added constraints is that this new organization significantly increased the number of interventions with a Self Contained Breathing Apparatus (SCBA), which increases the duration of the interventions and the number of people for the intervention (a minimum of 2 people is required an intervention using SCBA). Another example is that each subcontractor has to wear an H_2S detector when he works in the vicinity of the industrial equipments.

3.3.3 Control of the rules and procedures application that have been set up
This reorganisation had made it possible to set up a safety officer in each sector of the plant. One of his functions is to supervise the correct application of all rules and procedures by the subcontractors. If a sub-contracting company does not follow the procedures, the safety officer can remove their rights to work in the plant.
The number of field audits carried out by the in-plant staff has appreciably increased.
Each subcontractor must be capable of presenting a significant number of documents (e.g. the authorization of work duly signed, the procedure specific to the intervention, an analysis of explosimetry if the intervention requires it, a "check before action" form…) upon demand at all times while on the work site.

3.4 Results of this reorganisation
This reorganisation of the relationship between the client and the subcontractors let to an impressive improvement in the occupational safety of subcontractors. Using the TRIR[1] indicator the subcontractor's accident record dropped from 18 in January 2005 to 7.4 in January 2007. The number of subcontractors' accidents and incidents thus dropped by more than a half in 2 years. We can say that the main goal of this reorganization has been achieved.
These are the directly visible results of this reorganization, now we can inquire as to whether this reorganisation has other longer-term side effects on the practice of subcontracting in the plant.

4. Limits of this model and discussion

4.1 A model based on occupational accidents and prescription
We've seen that this reorganisation is based on the decrease of the occupational accidents of subcontractors and it has been done through the development of subcontractors' loyalty, through a rigid framework of the preparation and execution of the maintenance work, and through a high level of control before and during the execution of the work.

[1] TRIR: Total Recordable Incident Rate which represents the number of occupational accidents registered per million hours worked

4.1.1 Traditional approaches to reduce occupational accidents

Regarding occupational accidents there are roughly two kinds of approaches: the systemic approach and the behaviouristic approach.

The systemic approach

According to the systemic approach each event in an organisation can not be objectively be understood and explained, only if a study of the interactions between all the components of the global system is hold. For Smith (Smith, 1999) 85% to 95% of accidents have a common cause: a failure on the organisational system. According to this approach an accident cannot be explained in terms of one single cause such as a unsafe act; because this unsafe behaviour is the result of a combination of multiples factors such as the lay-out of the work-station, the pay policy, training, organisation of the work, communication with the supervisor… (Roy, 1994). In the systemic approach, the key to reducing accidents is in the improvement of all sub-systems and their interactions which constitute the work environment and determine the safety status. When these factors are known, checked and integrated into a management system, safety will improve with the understanding of managers and all the actors of their work environment. (Garrand, 2005)

Manzella (Manzella 1999) propose to focus on the compliance of the organisational system to pre-established standards such as ISRS[2] or OHAS 18001[3] to improve safety

This system approach promotes certification and the measure and correction of the gap between the norms and the organisational system.

The main critics of this approach are that it doesn't sufficiently encourage the involvement and the responsibility of employees and that the system decisions-makers are experts managers. The decisions are from top to down with a low contribution of workers.

In our plant, the ISRS system has been in place for years, and the plant has high scores, so we can say that a systemic approach is well-established. But the process set up is generally based on a top down system, a specific department works on the SIES and the majority of in plant workers are not really aware of this process so their contribution is very low.

Considering the special case of subcontracting, certifications have been created to enable subcontractors to work on risky installations such as petrochemical plants. For example the MASE[4] certification has been set up to minimise safety risks associated with the interference between the activities.

Now the MASE is a standard and only subcontractors that have the MASE certification or an equivalent can work on the plant we study.

The behaviouristic approach

For O'brien and Geller (O'brien, 2000) and (Geller, 2000), unsafe acts are the cause of accidents. In this approach to improve safety results you have to reduce the unsafe acts and increase safe behaviour and an action on the behaviours will promote a safety culture.

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[2] ISRS : International Safety Rating System by DNS, SIES in french

[3] OHAS 18001 : Occupational Health and Safety Assessment Series

[4] MASE : improvement of companies safety handbook

There are two well-known behaviouristic approaches: The behaviour based safety BBS process from Krause (Krause, 1997) and the STOP program from DuPont Demours (DuPont, 1997)
These two programs are based on observations during the work. Theses observations are made by workers or supervisors, with the authorization of the operator, and with a protection of its anonymity. Theses observations are then commented and a feedback is given to all employees.
In general, behavioural approaches allow workers to participate, drawing on their expertise. The feedback enables continuous improvement since workers are more aware of the demands of their employer.
The main critics of the behaviouristic approach are that it is often not incorporated on the global system of safety and that it can remove all sense of responsibility of the management. Regarding subcontracting, the behaviouristic approaches don't explore this situation, and no recommendations are given.
So the question is how to improve occupational safety in an "extended" plant that includes subcontractors from different companies? Each company may use its own program? How to coordinate these programs? What is the role of the client in this case?
In our plant the zero accident policy set up can not really be compared to a behaviouristic program because the observers are not workers but in plant preventors, and the observations are not anonymous.
The policy set up doesn't allow subcontractors to really take part on the observation and use their expertise. Subcontractors are audited and controlled and if something goes wrong there have to stop their work and their company can be blamed or in the extreme situations can be banned from the plant. We are here in a prescriptive policy with a safety officer control.
Another problem raised is that safety officer even being safety experts with all kinds of training can not be experts on all the maintenance trades. So maybe they can't see all the inappropriate practices when they observe subcontractors.

4.1.2 Occupational accidents are only one aspect of subcontractors' safety

In our research we have identified four aspects of safety linked with maintenance subcontracting:

- the first aspect is the work place safety and we've seen that the reorganisation proposed concerns only this problem
- the second aspect is the social status of subcontractors with the risks to be sub-workers who suffers from daily emergencies, flexitime, lying in wait (Thébaud Mony, 2001) and (Mayhew & al, 1997)
- the third aspect is linked with industrial safety and the equipment security during the execution of maintenance work. Subcontractors can make mistakes during their intervention that may have consequences on the plant safety, (Reason, 2004)
- the fourth aspect is linked with the hole subcontracting strategy of the plant and its management. This aspect is almost very difficult to look at because it refers to the middle and long term policy of the group about subcontracting. Despite, this aspect seems to us to be fundamental in the organisation of the relationships with subcontractors because it is a determinant factor on the way

the contracts are written and the day by day management of this subcontracting.

In this plant, these aspects of safety are managed by different departments and are segregated.

The organisation set up answers to one aspect of safety but doesn't assess clearly the impacts on others aspects of safety.

4.1.3 Limits of the prescription model

The plant chose to have a high prescription strategy that obviously increases the system safety when reducing significantly subcontractors' occupational accidents. But this strategy may hide some risks:

- Lot of procedures to be followed, lot of meetings where subcontractors must attend, lot of documents to present, which is to say, a model based on the written risks that can be far away from the field reality. All written procedures can not always be applied to the letter (Dekker, 2004).
- This model is not a learning model toward subcontractors because it gives very little breathing space and degrees of freedom to them (Argyris, 1999) and (Senge, 1994); if procedures don't strictly correspond to the work to get done, subcontractors are supposed to stop the operation. Subcontractors are continuously audited and controlled during their interventions.
- This model doesn't promote the adaptive capacities of subcontractors because it does not allow them to learn especially through errors, even if theses adaptive capacities are a request from the client. Subcontractors don't participate and their expertise doesn't rise with this program.

All in all this zero accident policy is based only on one result indicator which the TRIR. This policy despite having good results in the short term on the visible consequences of safety (a decrease of subcontractors accidents) may displace local disturbances to more serious risks associated with the inability of subcontractors to adapt in the long term to cope with the disruptions that the system suffers and on which the client asks them to intervene. This inability to adapt is mainly due to the reduction of their degrees of freedom and learning opportunities.

5. Perspectives of work and conclusion

This paper presents a model of subcontracting relationships in the context of ongoing maintenance of a petrochemical plant. We saw that this maintenance is a key factor in improving the plant performances. The organization of these subcontracting relationships has been reworded to decrease the accident rate of subcontractors. This reorganization based mainly on the increase of procedures to be followed by the subcontractors had decreased their occupational accident rate but others risks related to the ability to adapt to the long-term these subcontractors were raised.

Authors like Roy (Roy, 2004) think that the "A philosophy of learning rather a philosophy of performance focusing solely on performance indicators" has to be proposed regarding occupational safety. The real challenge of the occupational safety is to foster the emergence of a learning culture in the prevention and to improve process systems performances that determine the results.

We can't say that this model of subcontracting is a learning program. In essence this model is quite common in the industry and fairly trivial: it favours the short-term benefits through the TRIR indicator that are much better assessed that the long-term consequences.

The follow up of the research will focus on the characterization of a model of subcontracting, which combines the benefits of short-term security (decrease of occupational accident rate) and profits in the medium and long-term adaptive abilities of subcontractors. Our study continues with the identification of decision-making criteria for subcontractors under normal circumstances and situation worsened when the pressure of the client increases in particular in order to characterize the adaptive capacities of subcontractors to unexpected situations.

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