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Large Projects Integrators. Analysis and Management of the Data for Risk Assessment

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This paper shows the tools developed to collect, analyse and manage the data needed for risk assessment, within a large project integration activity in a country not covered by the safety regulations typical of European countries and the US.
The project, an aluminium mill, was a complex project with the contribution of worldwide machines suppliers, but not involving major risk processes; thus the safety data requirements, the level of analysis to be performed by the equipment providers, first, from the integrator and then from the final user in the end, was not stated.
The paper thus shows the framework and the tools developed to manage in the more complete and systematic way as possible the collection of data for safety, their analysis and their communication to the client.

1. Introduction

Effective risk management involves a four-phase process:

1. Hazard identification: The process of determining which risks may affect the project and documenting their characteristics.
2. Risk assessment: The process of prioritizing risks for further analysis by assessing and combining, generally, their probability of occurrence and impact.
3. Risk response: The process of developing options and actions to enhance opportunities and to reduce threats to the project objectives.
4. Risk monitoring and reviewing: The process of implementing a risk response plan, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating the risk process effectiveness throughout the project.
5. Risk project management is beneficial if it is implemented in a systematic manner from planning stage through the project completion. The unsystematic and arbitrary risk management can endanger the success of the project since most of the risks are very dynamic throughout the project lifetime.

When dealing with large projects, it is extremely important that the project integrator should be able to collect, analyse and supply to the final client all the information to support the risk assessment, that the

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last will perform, usually on the base of local regulations and in any case with dedicated methodologies (Nieto-Morote and Ruz-Vila, 2011; Aneziris et al., 2010; Tah and Carr, 2001)
In Marra et al. (2012) it is shown that the areas of supply chain management where a knowledge management is commonly applied are outsourcing, decision support and risk management and mainly in the construction industry.
Lee (2004) pointed out that efficient knowledge flows and knowledge sharing process among supply chain partners give them the following characteristics: agility, adaptability, and alignment. These characteristics allow them to be the best performers.
On the other hand, given the possible high number of different suppliers from different countries around the world this data collection could be difficult, both in terms of data availability and of data quality, if not supported by a framework able to guide the integrator in the request for information. This framework, intended as the conceptual and procedural constructs that assimilate, process and give meaning to information, as in Assmuth and Hilde´n (2008), is described in the following paragraphs.

2. Functional analysis

A complex humane-machine system is seen as being composed of humans, of machines, and of the interaction between them, which could properly be described by a system model. The role of a system model is essential in thinking about how systems can malfunction, or in other words in thinking about accidents.
As described in Marhavilas et al. (2011), the facility has been divided into manageable, logical sections (systems or units). Section limits have been identified where there is a significant change in the process conditions, a change in location or in material phase and composition.
In particular, the main division has been identified in:

A. processing units,
B. storage areas
C. utilities
D. maintenance unit
E. auxiliary equipment
F. handling systems summary
G. building

Table 1: Logical-functional units based on plants PFD

LOGIC - FUNCTIONAL UNITS (BASE PFD)
E1 - MELTING / HOLDING FURNACES
E2 - METAL TREATMENT & FILTRATION
E3 - HAZELETT CASTER
E4 - ROLLING MILL
…
E8 - WRAPPERS
E9 - ROLL GRIND SHOP EQUIPMENT
STORAGES
UTILITIES
MAINTENANCE UNITS
AUXILIARY EQUIPMENT
HANDLING SYSTEMS
BUILDINGS

A first sub-division can been derived from the project technical documentation, and then a check with the design supervisors has to be carried out. The sub-division into main functional groups is shown in Table 1.

In particular for each unit, beyond the functional subdivision based on PFD and operations, two further aspects was taken into account:

1. auxiliary utilities, that are the utilities dedicated to the single unit;
2. critical maintenance operations, that represent those operations not directly devoted to the production, e.g. the substitution of rolls, but very relevant for the product quality and frequently performed.

An example of functional subdivision is shown in Table 2, for main unit E1 – Melting/holding furnaces.

Table 2: Functional sub-division for Unit E1

E1 - MELTING / HOLDING FURNACES
SOLID CHARGING
LIQUID CHARGING
ALLOY POWDER INJECTION
MELTING
FLUXING
SKIMMING
SAMPLING
DISCHARGE (to casting)
AUXILIARY UTILITIES
HYDRAULIC SYSTEM
EQUIPMENT ELECTRICAL SYSTEM
CRITICAL MAINTENANCE OPERATIONS
CLEANING OPERATION

2.1 Characterisation of functional units

The first columns in the support synoptic table are thus devoted to the characterisation of functional units, as in Table 3.

A column for "reference documentation is also foreseen in order to allow a traceability of the information included in the table.

Table 3: Characterisation of functional units

LOGIC - FUNCTIONAL UNITS	**RELEVANT PARAMETERS**	**MACHINES - EQUIPMENT RELATED TO SAFETY ISSUES**	**TYPE OF OPERATION**
Defined as in previous paragraph	For each sub-function describes the relevant process parameters in terms of temperatures, pressures, flow-rates, materials, physical states, etc.	List of main machines and equipment that could be relevant for safety, being characterised by specific risks	A=Automatic M=Manual This parameter highlights the need for **access control** to the unit.

2.2 Handling systems and utilities

The second section of the synoptic table is devoted to the description of the handling system used or activated by each sub-function, the materials handled and the possibility of interferences within handling systems and handling systems or handling systems and plant operators.

Table 4: Handling system characterisation

HANDLING SYSTEMS						
Liquid metals	Solid metals	…	…	Auxiliary tools & Consumables	Interferences during operational phase	
					HS/OP	HS/HS
Each column represents the materials that have to be handled within the plant. For each sub-function, the handling system used to transfer the different materials will be highlighted.					In case some interference within handling systems or within an handling system and a operator could be possible, a check in this column will identify the need for **access control** or **interlocks**	

The following section is devoted to the utilities that support each sub-function. The utilities can be:

- general utilities of the plant (as natural gas or nitrogen) and in this case they are analysed in the "Utilities" main section.
- Local utilities and in this case they are analyse at the end of the same sub-function as "auxiliary utilities".

2.3 Risk classification

The following section is devoted to the risk classification for health and safety according to the EN ISO 12100-1:2010, with some minor modifications in order to take into account all relevant hazards (Gilbertson, 2007). The risks are classified in the following classes:

1. Mechanical hazards
2. Thermal hazards
3. Physical hazards
4. Material substances
5. Other hazards

Wherever a potential emission in the air or water or ground is present also a verification of the possible environmental hazard is foreseen. On the base of the hazards identified for each sub-function, the requirements for safety studies are derived.

3. Safety Studies

On the basis of the functional analysis and hazard preliminary identification, the need for risk analysis and the information flow between the integrator and the suppliers have been identified, as in Table 5, where a sample part of the Table is shown.

The Table shows the risk analysis or mapping requirements, subdivided in 3 sections:

- Health (H)
- Safety (S)
- Environment (E)

It also identifies the information flows and the sample reference standards, regulations and methodologies.

The logical process underlying the identification of safety studies needs is described in Table 6.

4. Conclusion

In the present paper a framework able to guide the integrator in the request for information useful to collect and analyse the safety data from different actors in a large integration project has been shown.

The framework is made of a synoptic table able to organise the main characteristics of the project based on a functional analysis, which contains the data relevant for the hazard analysis and that allows to highlights the safety study needs.
The framework also contains a tool for the systematic exchange of information between the integrator and the suppliers of the equipment able to summarise the presence and the position within the technical documents provided by the supplier of the relevant data about safety. This framework, that can be easily adapted to different projects, has been successfully tested in a large integration project: an aluminium rolling mill plant in the Middle East.

Table 5: Key table of safety studies

SAFETY STUDIES	H	S	S	S
	Hazardous materials and unhealthy atmospheres	**Machineries**	**Area classification (ATEX)**	**Fire safety**
INFORMATION FLOW	Vendor must receive from the integrator the list of foreseen hazard and risk to be taken into account	Vendor must receive from the integrator the list of foreseen hazards and risk to be taken into account		
	Vendor must provide the integrator with the risk assessment HazMat during normal operation	Vendor must provide the integrator with the risk assessment of machineries.	Vendor must provide the integrator with the area classification related to its supply	Vendor must provide the integrator with the fire safety hazards and protection systems of its equipment
	The Integrator will collect documents and provide them to the client	the integrator will collect documents and provide them to the client	the integrator will integrate the area classifications, analyze it for design purposes (building, utilities, electric power) and provide it to the client	the integrator will integrate the analysis for design purposes (signals, exits, emergency planning) and provide it to the client
REFERENCE STANDARDS, REGS AND METHODS	OSHA 29CFR 1910 H – Hazardous materials HSE (UK) – Estimation and Assessment of Substance Exposure (EASE) model	EN ISO 12100:2010 - Safety of machinery -- General principles for design -- Risk assessment and risk reduction	IEC 60079-10-1:2009 Explosive atmospheres — Part 10-1: Classification of areas - Explosive gas atmospheres	ISO 19353:2005 Safety of machinery -- Fire prevention and protection ISO/TS 16732:2005 Fire safety engineering -- Guidance on fire risk assessment OSHA 29CFR 1910 L – fire protection

Table 6: Logical framework (with reference to the safety studies in Table 4)

		H	S	S	S
		HAZARDOUS MAT. & UNHEALTHY ATM.	**MACHINERY**	**AREA CLASSIFICATION (ATEX)**	**FIRE SAFETY**
TYPE OF OPERATION	Manual				
	Automatic				
	HANDLING SYSTEM				
INTERFERENCES	HS/OP				
	HS/HS				
MECHANICAL HAZARDS	Moving parts and materials		x		
	High pressure fluids		x		
	Fragment & liquid metal projection		x		
THERMAL HAZARDS	Hot surfaces				
	Hot environment				
PHYSICAL HAZARDS	Noise		x		
	Vibration		x		
	Radiation		x		
MATERIALS AND SUBSTANCES	Composition, toxicity	x			
	Atex			x	
	Fires				x
	Breathable atmospheres	x			

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