Environmental and Health Management in Small and Medium size Enterprises

By

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ABSTRACT

Workers and employees are increasingly exposed in the workplace to chemical compounds and substances that are potentially toxic; for most of these compounds, no information exist regarding effects on human health.

As one of the main employment generation sources, Small and Medium size Enterprises (SMEs) host a significant proportion of the environmental hazards currently present in the workplace. However, only a negligible amount of research or information has been completed and collected concerning SMEs environmental and health performance.

SMEs possess environmental perceptions and an environmental and health behavior conditioned by the same qualitative attributes inherent to the small firm, from the kin relationships among the business members to the social role of the small company in a given community. With a prominent economic and social role in the society, SMEs are an important and still underestimated link in the environment-to-health chain.

This thesis proposes an Environmental and Health Management model for SMEs. The model considers the convergence of medical, environmental, labor, and safety approaches and explores their interrelationship in three main components: the environmental conditions in the workplace, the (individuals) health conditions in the workplace, and the work-related conditions in the workplace.

Nine fields of knowledge (Industrial Safety, Occupational Health, Occupational Medicine, Epidemiology, Industrial Hygiene, Toxicology, Environmental Health, Environmental Management, and Risk assessment) are considered as useful tools and approaches whose interaction may help SMEs to shape or modify their environmental perceptions and behavior, as well as may provide a general framework for the regulations applicable to SMEs.

Thesis supervisor: Lawrence Susskind
Title: Ford Professor of Urban and Environmental Planning

Biographical Note

Juan C. Arredondo (the author) holds a Master of Science in Environmental Engineering (1997-2000) and a Bachelor's degree in Chemical and Systems Engineering (1992-1997), both from ITESM.

Over his professional life, the author has collaborated as project leader, research coordinator, analyst, and consultant on a variety of projects on process efficiency, waste minimization, urban sustainability, and environmental management with the World Bank, the United Nations Center for Human Settlements, and with a number of large and small companies in the printing, electronics, beverages, and tannery industrial sectors in Mexico.

Previous to his enrollment at MIT, he worked as Strategic Programs Director for the Jalisco State Council of Science and Technology, as Associate Director of Grupo Strategia Corporativa Mexico, S.C., and as Research Assistant in the Environmental Quality Center at ITESM. In addition, the author has professional experience as Professor and Lecturer on Ecology and Sustainable Development at ITESM.

Among the honors received, the author has been awarded a Fellowship from the Instituto Nacional de Ecologia for his studies at MIT, a Research Assisstant Fellowship from ITESM, and an official recognition from the World Business Council for Sustainable Development for his dominion of Sustainable Development topics.

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Chapter 1: Introduction

Workers and employees in activities as varied as wholesale trade, textile mill production, plastic manufacturing, insurance, real state, personal services, or printing and publishing are exposed to thousands of chemicals every day. More than 80,000 chemical products are currently in use and approximately 2,000 more new chemicals are added to the market every year (Enander, Gute, Cohen, 313). According to the United States Environmental Protection Agency's Toxic Release Inventory, reported releases for 522 chemical compounds during 2001 show that more than 750 million tons of chemical compounds were emitted to the air, more than 100 million tons were discharged to surface water, and more than 1,500 million tons were released to the land solely in the United States. Among the 522 chemical compounds included in the list are asbestos, ammonia, arsenic compounds, heavy metals (like chromium, mercury, and lead), pesticides (like malathion), and solvents (like toluene, xylene, benzene, acetaldehyde, and derived compounds), just to mention a few.

Many of the chemicals already present in the work environment are potentially toxic and for the most of them, there is not even enough information regarding their effects on human health (Timbrell, 1). Of the 80,000 chemical products currently in use, only 200 to 300 chemical compounds have been identified as mutagenic or carcinogenic with adverse effects on reproduction; 300 to 350 chemical, physical and biological factors have been identified as occupational carcinogens; and about 3,000 have been identified as allergenic factors, many of which occur as occupational exposures (WHO, 23).

As a result, an increased number of fatal and non-fatal illnesses and diseases, and increases in mortality risks from exposures in the workplace are now a reality. According to the United States National Institute for Occupational Safety and Health, nearly 19% of all non fatal illnesses and diseases in the United States such as dermatitis, poisoning, and respiratory disorders are related with exposures to heavy metals, organic solvents, pesticides, chemical products, or toxic agents (NIOSH, 2002). Furthermore, about 13% of all occupational non fatal illness cases reported in the United States by 2002 were skin diseases or disorders, 53% of which were job-related dermatitis from exposures to chemicals and chemical products; 5% of all occupational non fatal illnesses reported were respiratory disorders attributable to toxic agents in the work environment, with incidence rates that reached 77 cases per 10,000 workers; and 1% of all occupational non fatal illnesses reported were poisoning cases, 55% of which occurred in the manufacturing industry (NIOSH, 2002). Similarly, the World Health Organization has estimated that about 20 to 30% of the male and 5 to 20% of female working-age population of the world (15-64 years old) may have been exposed to work-related carcinogens (WHO, 2002).

Workplace prevalence and incidence rates have become common measures in health statistics publications while occupational illnesses, such as chronic pulmonary diseases, ischemic heart diseases, myelodysplasia syndromes, or malignant neoplasms, are regularly documented.

Even with stringent regulations concerning product development, product properties for human consumption, and waste disposal, industrial societies still suffer from the burdens of environmental hazards in the workplace.

Much of the effort to reduce the burden from environmental hazards and improve the workers' situation towards a healthy workplace is done at large firms. A substantial amount of publications, mostly focused on large firms, elaborate on the links that exist between business management practices and environmental and health conditions in the workplace (Sharfman, Shaft, and Tihanyi, 2004; Rosenberg et al., 2001; World Bank, 2001; NBER, 2000). However, only a negligible amount of research has been completed concerning Small and Medium size Enterprises[1].

Small and Medium size Enterprises (SMEs) are an important part of every country's economy. Worldwide, they represent between 90 to 98% of total number of businesses, make up between 20 to 40% of total employment, contribute to nearly 60% of private sector employment, and generate approximately 50% of Gross Domestic Product (OECD, 2000; APEC, 2002).

As may be inferred, SMEs may also make a relevant contribution to environmental hazards and associated work-related problems. In environmental terms, some studies suggest that SMEs could contribute as much as 70% of all industrial pollution (Ammenberg and Hjelm, 2003). In health terms, data from the Worker Health Chartbook

[1] Some examples on SME research can be read from Ammenberg and Hjelm, 2003; Dyllick and Hockerts, 2002; Petts et al, 1999; Frijns and Vliet, 1999; Tilley, 1999.

prepared by the National Institute for Occupational Safety and Health shows that during 1997, higher rates of fatal occupational injuries occurred in business with less than 100 workers with the rate (by a factor of 4) in those establishments with 10 or less workers (NIOSH, 40).

SMEs have wide presence, play a prominent role in every society, and constitute an important underestimated link in the environment-to-health chain. Therefore, greater interest and effort should be put in place towards a deeper understanding of their organizational practices, their operation, their environmental and health performance, and their overall impact on environmental terms and on people's health.

A greater insight on SMEs may be obtained from a review of their quantitative and qualitative attributes. As will be shown in Chapter 2, many nations have a quantitative definition of SMEs that considers number of employees, asset value, annual sales, capital investment, or production capacity. However, current classifications are used for statistical or policy purposes, and rarely to address the prevalence of work-related environmental hazards and their effects on human health, or to propose specific environmental or health management practices for small firms.

SMEs can also be analyzed qualitatively by the way they are organized, by the linkages among their personnel, or by their managerial practices. A review of these qualitative attributes may increase our understanding of the attitudes and behavior that small firms have concerning their workers' health and the firm's environmental performance.

Non-compliance with environmental or health and safety regulations has been documented as a generalized condition on small firms. Authors have tried to explain the non-compliance situation by questioning the environmental ethics of small firms (Tilley, 2000), by analyzing the gaps between environmental attitudes and environmental behavior of small businesses (Tilley, 1999), by studying the climate and culture of small firms (Naffziger, Ahmed and Montagno, 2003; Petts et al., 1999), by reviewing the barriers in the policies (Revell and Rutherfoord, 2003), and by evaluating the support programs specifically created for small businesses (Barbeau et al., 2004; Gallup and Marcotte, 2004; Kürzinger, 2004; Friedman and Miles, 2002).

During qualitative research on SMEs, based on specifically designed surveys, owners, managers, and employees have expressed a number of explanations for their non-compliance (Revell and Rutherfoord, 2003; Friedman and Miles, 2002; Petts et al, 1999; Tilley, 1999; Holland and Gibbon, 1997). These explanations can be clustered as: (1) limited access to capital, credit opportunities, and financial resources; (2) low level of knowledge, training, and awareness on environmental regulations and environmental hazards; (3) lack of market incentives; and, (4) legal constrains or restrictive policies and regulations (Bethlehem and Goldblatt, 168; Felsenstein, 15). Derived from this reasoning, SMEs present a general lack of interest in compliance and, furthermore, perceive compliance as a disproportionate cost for the firm.

SMEs environmental and health performance is also partially related with the regulatory framework. National, regional and local governments have increasingly developed regulations in order to create an attractive business environment, promote healthy and safely working environments within the firms, and overall, maintain the well being of the population. Regulations and standards have been created for different types of environmental media (air, water, soil), different types of pollutants (solid, liquid, hazardous, non hazardous), and diverse areas of application (from occupational health to labor standards to public health). However, even with the current regulatory framework put in place, no further incentive is found and SMEs still exhibit a low level of compliance.

From a governmental point of view, SMEs' ubiquity represents a major challenge when trying to enforce regulations compliance. Common explanations have been framed as barriers to effective enforcement; among them are the following ones: (1) the lack of economic and human resources to conduct regular inspections and audits; (2) the limited institutional support received from superior levels in the governmental hierarchy; (3) the ineffective regulatory framework; (4) the cost of monitoring systems; and, (5) lack of information about the real situation of SMEs.

Limitations and barriers in the regulatory framework enforcement may be supplemented by an interaction between environmental and health standards. The interaction does not promote dilution of responsibilities nor an overtaking of competence spheres for different regulatory agencies.

Diverse fields of knowledge that may interact at the firm level, such as Epidemiology, Occupational Health, Environmental Health, Risk Assessment, and Environmental Management, have overlapping concerns and interests that can converge in environmental and health standards or programs directed to the small business sector.

From their interaction, these sciences may help to: (1) identify and quantify the environmental hazards at the workplace; (2) identify and quantify the occupational exposures; (3) identify the etiology of workplace illnesses and diseases; (4) estimate the incidence or prevalence rates of occupational illnesses and diseases per industrial sector; (5) estimate the health and compensation costs from years of life lost (YLL) or from disability-adjusted life years (DALY); (6) recognize the preventable diseases; and (7) integrate assistance programs or develop environmental and health standards specifically designed for small firms.

Conclusions

A growing number of chemical substances and compounds are commercialized each year and many of them are present in the workplace environment. As a result, workers and employees in economic activities as varied as plastic manufacturing or insurance are already exposed to thousands of these chemicals everyday.

Despite not enough information regarding their effects on human health has been collected, it is possible that they pose an increased risk and may be the cause of a number of fatal and non-fatal illnesses and diseases. Consequently, occupational factors and work-related exposures are now important contributors to the global burden of disease (Leigh, 626).

Small and Medium-size Enterprises play an important economic and social role in most of the countries in the world. A significant proportion of employment generation occurs at the SME level. At the same time, SMEs have an associated environmental performance that may create a health hazard or a burden for their own employees or for the society as a whole. With an increasing percentage of the world population entering into the global workforce and with a growing mobility of worker population, it may be expected that more environmental hazards and burdens derived from occupational settings would affect the society (Leigh et al. 1999; WHO, 1995).

From empirical research, it has been recurrently documented the SMEs' lack of compliance with environmental and health regulations. Four explanations commonly appear as main reasons to lack of compliance: (1) limited access to capital, credit opportunities and financial resources; (2) low level of knowledge, training and awareness on environmental regulations and environmental hazards; (3) lack of market incentives; and, (4) legal constrains or restrictive policies and regulation.

Three of these four reasons are related to the particular SMEs attributes. Their operation, the personnel understanding and awareness of the health effects of environmental hazards, and the managerial practices shape the firm's attitudes and behavior regarding the environment and the health status of employees.

The regulatory framework appears as the fourth main reason for lack of compliance. An integrated regulatory approach considering environmental and health management in small businesses may represent a more comprehensive and effective approach. Different disciplines with overlapping concerns and interests, such as Epidemiology, Occupational Health, or Risk assessment may have a contribution to this effort.

The hypothesis for the present thesis is that an improved understanding of SMEs attributes would help to develop standards or assistance programs to increase regulatory compliance. A joint approach on environmental and health management, with a focus on the increased health risk of environmental hazards at the individual level, would increase the stakes for the managers and workers of small firms and for the society as a whole. Consequently, an improved small firms' performance, an overall regulatory compliance, and a reduction on future health costs from work-related diseases may be expected.

Chapter 2: Small and Medium size Enterprises: definition and characteristics

Small and Medium size Enterprises are significant in economic, social and environmental terms. They represent between 90 to 98% of total number of businesses, make up between 20 to 40% of total employment, contribute to nearly 60% of private sector employment, and generate approximately 50% of Gross Domestic Product (OECD, 2000; APEC, 2002).

Although a small amount of information on the environmental impact of small firms exists, it is generally estimated that their cumulative impact could be considerable (Tilley, 33) and, in some cases, may represent up to 70% of total industrial pollution (Ammenberg and Hjelm, 2003).

Within the firm, SMEs workers are exposed everyday to an increased number of environmental hazards and risks that may trigger the development of certain types of diseases, such as chronic pulmonary diseases, ischemic heart diseases, myelodysplasia syndromes, or malignant neoplasms.

A look to the current definitions and attributes of SMEs may improve our initial understanding of their dynamics, including the motives behind their attitudes and behavior, and may act as a baseline from where to build up towards a more integrated approach on environmental and health management.

Quantitative definitions

There is no international agreement on the definition of Small and Medium size Enterprises. Often, nations use a quantitative criterion to establish an adequate SME definition. Most of the times, the quantitative criteria may include features such as number of employees, asset value, annual sales, capital investment, or production capacity. As seen on Table 1[2, 3], among the most common quantitative features used are the number of employees combined with the annual sales.

Based on quantitative features, nations develop SME definitions for statistical or policy-making purposes. However, a quantitative definition is useful only if provides an adequate framework and enough information for the desired statistical purposes, or if provides a basis for the adequate allocation of resources and follow-up of goals accomplishment when implementing the respective policies or support programs.

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[2] Not all of the definitions for the more than 25 countries reviewed appear in Table 1. The review was performed for list of countries from Asia, Europe, North America, and South America. For more detailed definitions, see APEC, European Union and OECD references included in bibliography.

[3] + This is a general definition, and do not distinguishes between Micro, Small or Medium.

Table 1 notes:

[1] United Nations Economic Commision for Europe. http://www.unece.org/indust/sme/def-cit.htm

[2] APEC. Profile of SMEs and SME Sigues in APEC 1990-2000. http://www.apecsec.org.sg/

[3] Serviço Brasileiro de Apoio às Micro e Pequenas Empresas (SEBRAE). Estadisticas sobre MPE. http://www.sebrae.com.br/br/ued/index.htm

[4] European Union. Commission Recommendation of 6May 2003concerning the definition of micro, small, and medium-size enterprises. http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_124/l_12420030520en00360041.pdf

[5] Government of Hong Kong. Trade and Industry Department. Virtual SME Information Center. http://www.sme.gcn.gov.hk/smeop/english/smehk.cfm

[6] Minister of Economy. Diario Oficial de la Federación (DOF) December 30, 2002. p.51. http://www.dof.gob.mx/2002/diciembre/dof_30-12-2002.pdf

[7] Minister of Economic Affair. SME Definition Standards. http://www.moeasmea.gov.tw/eng/develop_env/c02.asp

[8] UK. Department of Trade and Industry http://www.smallbusinesseurope.org/SMEdefinition_html

Statistical or policy purposes aside, SME definitions may additionally differ among countries by industry type or by policy program (APEC, 2). As an example, a further classification per activity is sometimes used, as can be shown in the SME definitions from Brazil, Japan, Mexico, or Taiwan. In theses cases, the retailing, manufacturing, or services activities are considered for an additional classification within a specific size category.

Given the lack of agreement among quantitative definitions, it is not possible to completely understand SME dynamics based solely on numbers. Among SME researchers, the variations in the quantitative definitions have fostered the use of qualitative features as SME definers.

Table 1: SME definition by number of employees and annual turnover (in USD).

Country	Médium		Small		Micro	
	Employees	Turnover (USD)	Employees	Turnover (USD)	Employees	Turnover (USD)
Albania[1]	50-250	•	10-40	•	< 10	•
Australia[2]	21-200	•	5-20	•	< 5	•
Brazil[3]	Manufacture: 100-499 Retail / Service: 50-99	< $412,000 and > $80,000	Manufacture: 20-99; Retail / Service: 10-49	•	Manufacture: < 19; Retail/ Service: < 10	< $80,000
Bulgaria[1]	•	•	< 50	•	•	•
Estonia[1]	•	•	< 80	< $1,200,000	•	•
European Union[4]	< 250	≤ $61,000,000	< 50	≤ $12,000,000	< 10	≤ $2,500,000
Japan[2]	Manufacture: < 300; Retail: <50; Service: <100	•	•	•	•	•
Hong Kong[5]	Manufacture: < 100; Non-manufacture: <50	•	•	•	•	•
Malaysia[2+]	< 150	< $6,500,000	•	•	•	•
Mexico[6]	Manufacture/service: 51-250	•	Manufacture/service: 11-50	•	0-10	•
	Retail: 31-100	•	Retail: 11-30	•		•
Moldova[1]	•	•	20-75	•	< 20	•
Romania[1]	21-200	$300 - $62,000	1-20	$300 - $62,000	•	•
Taiwan[7+]	Manufacture: < 200; Non-manufacture: <50	< $300,000	•	•	•	•
Slovakia[1]	25-500	•	1-24	•	•	•
Singapore[2]	< 200	•	•	•	•	•
United Kingdom[8]	< 250	< $20,000,000	< 50	< $5,000,000	•	•
USA[2]	Manufacture: < 500	Non-manufacture: <$5,000,000	•	•	•	•

• No specific definition exists or data not available.

Qualitative characteristics

A qualitative approach allows us to understand in a more comprehensive way the form in which SMEs take decisions, organize themselves, operate in a day-by-day basis, acquire or develop sources of capital, and develop perceptions and attitudes towards their environmental and health responsibilities with their employees, their neighbors, and their community.

Although characteristics such as links between management and ownership, decision-making process, and management style are some of the qualitative features used to define a firm as SME, a common practice in the SMEs' research field is to simply denominate SMEs as family businesses, based on the size and the dynamics of the companies. This denomination generates additional definitions. As an example, family businesses have been defined in the United Kingdom as "a firm where a family member is the chief executive officer and where there are at least two generations of family control with a minimum of 5 percent of voting stocks held by the family or trust interest associated with it" (Colli, Fernandez and Rose, 30).

Definitions on family businesses vary internationally and are only valid to the context of the country under study. A number of additional attributes, such as kinship, firm origin, financial control, or shared culture and values, may then be used to define SMEs.

Relations among SME members

SMEs identified as family businesses can be defined in terms of the relations among its members. According to the genealogical relationships and social ties within a small business, three types of kin-based enterprises have been identified: blood and marriage, spiritual, and community-based businesses (Peredo, 2003).

Members of blood and marriage kin-based firms have a patrilineal or matrilineal blood relation among them (father, son, cousin, aunt) or were affiliated to the business as product of a marriage with one of the members (Peredo, 398).

In spiritual kin-based firms, different social, cultural and religious rituals are the means of affiliation (i.e. through *padrinos-ahijados*[4] or *compadres*[5]). Such rituals or customs expand the relationships among the members beyond the biological family (Peredo, 398). Spiritual kin-based businesses are particularly common in Latin America.

In community-based firms, large groups of families are tied by common history or ancestry (Peredo 399) as may be the case of Chinese or Korean business communities located in cities or countries outside of their own country of origin. From their common ancestry, families establish networks of businesses in a variety of economic activities.

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[4] *Padrino-ahijado* is equivalent to the godfather-godchild relationship.
[5] *Compadre* is equivalent to the godfather of one's child; as plural, *compadres* make emphasis on the relationship between a godfather and the father of the godchild.

In any of the three types of businesses, kinship relations allow access to resources, entails obligations (Peredo, 398), and define who does and who does not belong to the family (Peredo, 397).

The kinship-based classification of SMEs is particularly important because allows the policymakers or the field practitioners to easily identify a small firm and understand part of the internal processes that occur within the business. Moreover, the kinship-based classification allows us to understand how SMEs have access to sources of capital, what is their employee turnover, which market approaches they use, and what type of environmental awareness and social support they have. In general, kinship may partially explain the general dynamics of any SME around the world considering small variations derived from socioeconomic conditions or cultural environments (Peredo, 2003). A summary of SMEs attributes under the kinship-based classification are shown in Table 2.

For a small firm, the business value of kin relations lies in the access to resources in the form of low labor cost, existence of a pool of economic resources, a direct access to markets, and in the resultant wealth generation within the community. Additional value arises from their inherent flexibility to timely adapt to market opportunities, backed up by the social support they receive from their community. In many cases, the value of these resources may be underestimated by researchers or policy makers.

The SME management style, in addition to the existent ways of affiliation to the business, the attributes on access to resources, and the value derived from kin-based relations, is also important. Managerial practices and actions have a particular influence in shaping decisions, perceptions and attitudes within and around the company.

Table 2: Kin-based classification of SMEs: comparison.

	Blood and marriage	Spiritual	Community based
Sources of capital	Own savings (individual or couple), close relatives, or close friends loans	Pool of resources	Extended pool of resources
Employee turnover	Low	Low	Low to medium, tied with education (search for 'additional' opportunities)
Labor cost	Low	Low	Low
Approach to markets	Limited to personal mobility	Local and regional, based on connections	Local and regional, based on connections
Learning and innovation	Limited, based on the person skills	Communal knowledge; fostered by a 'champion'	Communal knowledge; local or shared; fostered by a community leader or 'champion'
Social support	Close family and close friends	Extended family beyond biological family	Neighborhood, own community. Large groups of families
Environmental awareness	Poor, based on own eco-literacy	Low, dispersed in the collective knowledge	Low, dispersed in the collective knowledge
Health management	Care of own health	Long-term obligation for protection	Medium, based on community experiences from different sources, in addition to care for own health
Rules for kinship incorporation	Blood relations	Social, cultural, and religious rituals	Clan, ancestry, and common history

Management style

Kin-based small firms may use norms of kin or norms of market as part of their managerial style with opposite results as an outcome. Norms of kin are directed to long-term generalized reciprocity among family members, while norms of market are directed towards short-term balanced reciprocity (Stewart 385).

In other words, norms of kin focus on strengthening the family liaisons or the kin liaisons by satisfying short-term needs and creating a long-term commitment among the members. Norms of kin are assumed to be axiomatically binding (Fortes in Stewart, 385) and have as a purpose to build trust and indebtedness. A flow of gifts among members may be a common practice in firms run under norms of kin.

On the other hand, norms of market focus on the aspect of business property. Under norms of market the "family members resolve the perceived inequities by dividing the family estate and by starting new branches of the firm" (Stewart, 386). In this case, the prevalence of the business in the long term represents an incentive and a vehicle to resolve internal differences. Nepotism may be a recurrent practice under both types of managerial style.

Many times the short-term family needs and the nepotism involved in the decisions take over the experience or the capability of employees. As a result, company decisions are molded through personal influence within the organization or through personal influence on leadership succession, regardless of any labor market logic (Stewart, 386) and "unfettered by any formal institutional regulation or governance" (Colli, Fernandez-Perez, and Rose, 31).

Valuable knowledge or skills held by employees outside the boundaries of the family and that may contribute to a competitive advantage of the firm can be lost during the effort to build and maintain the network's trust and cohesiveness.

As may be expected, the prevalence of one set of norms over the other, the nepotism, and the personal influence of the firm members within the business radically change the small businesses attitudes towards their environmental performance and their concern of their workers' health. Moreover, SMEs' managerial style does not guarantee any improvement in the environmental and health performance of the firm. A summary of both types of management style are shown in Table 3

Table 3: Management styles in SMEs: comparison

	Management style	
	Norms of kin	**Norms of market**
Approach	Family or kin ties and liaisons	Market and business prevalence
Attributes	• Long term relationships • Forge reciprocity among members • Build trust and indebtedness • Axiomatically binding • Nepotism	• Focus on business property • Division of family estate or asset • Start new branches of the firm • Nepotism

Environmental attitudes and behavior

Diverse studies have tried to explain the motives behind small firms' attitudes and behavior towards the environment. Authors have questioned the environmental ethics of small firms (Tilley, 2000), have analyzed the gaps between environmental attitudes and environmental behavior of small businesses (Tilley, 1999), have studied the climate and culture of small firms (Naffziger, Ahmed and Montagno, 2003; Petts et al., 1999), have reviewed the barriers for compliance with the policies (Revell and Rutherfoord, 2003), and have evaluated the support programs specifically created for small businesses (Barbeau et al., 2004; Gallup and Marcotte, 2004; Kürzinger, 2004; Friedman and Miles, 2002). Most of the research is empirical studies done with samples of small businesses where questionnaires, surveys or visits to the company were used as tools to gather information.

Different answers have come to the table. Some authors suggest two types of forces that shape SMEs' environmental attitudes and behavior: the resistant forces and the driving forces (Tilley, 241).

According to Tilley, the main resistant forces against proactive and effective environmental attitudes and behavior are the following: (1) a low standard of eco-literacy, (2) a poor level of environmental awareness, and (3) the prominence of economic imperatives behind firms' decisions.

The effects of the resistant forces are threefold: (1) small firms are ill informed and unwilling to take action; (2) small firms do not perceive to have any environmental problems, either because the impacts are perceived as too-small or inexistent; and, (3) small firms perceive that the reduction of environmental impacts is a cost burden (Tilley, 241).

Lack of information and low levels of eco-literacy or expertise may result in poor perception of their environmental problems and in reactive responses to environmental issues (Revell and Rutherford, 2003). The unwillingness to take action will prevail unless they are threatened by strong external forces such as prosecution or customer demands; consequently, a significant amount of pressure has to be put over the businesses in order to obtain a proactive response.

From those small firms who have acquired or developed a proactive response, three types of external forces have been identified as modifiers against the unwillingness to take action: (1) personal concern, (2) corporate image, and (3) stakeholders influence.

Many of the workers and managers who have participated on empirical studies have expressed a personal concern about the environment (Revell and Rutherfoord, 2003; Tilley, 2000; Petts et al., 1999; Tilley, 1999; Ashford, 1993). This individual concern may involve local environmental issues, such as nearby waste dumpsites, and global commons, such as air quality, water quality, ozone depletion, or global warming (Petts et al., 20). As concluded by Petts et al., "[t]he environment is important to individuals at a social level" (Petts et al., 19). However, not all the personal concerns and attitudes are reflected or translated into a practical behavior at the firm level.

The unwillingness to take action may not only respond to a lack of information or the absence of threatening external forces. Personal concerns may obey to a socially acceptable behavior that rewards the individual in a social way, i.e. acceptance and trust. From studies on small firm environmental ethics, SMEs have expressed a feeling that, although willing to do something, they are not best placed to identify what actions are needed in order to manage their environmental responsibilities in a sound and acceptable manner (Tilley, 35). As a result, the individual concerns cannot be elevated up to the firm level with a resistant force, such as low level of eco-literacy, in opposition to any practical behavior.

A socially acceptable behavior can be linked with the firm environmental behavior. Research on the climate and culture of SMEs has suggested a common belief among firms that pollution of the environment always leads to harm (Petts et al., 20). Compared with an individual general concern about the environment, the aforementioned belief assigns a greater immediacy and relevance to the health and safety of the firms' employees. Such a belief has important implications for the SME owners in terms of complying with the right thing to do.

The regulatory framework may support the belief of the right thing to do by emphasizing and providing information about the harmful effects derived from environmental pollution. If the regulatory framework is so adjusted, non-compliance and unwillingness to take action can be associated to a harmful practice at the firm level. If so achieved, it can be assumed that a firm's compliance with those environmental (or related) regulations that reduce their harm to the people may be socially framed as an acceptable behavior. If a lack of concern over the environment becomes a socially unacceptable behavior then adverse publicity and damage to the company image may well act as a motivator at the firm level.

Even with adjustments to the regulatory framework and the belief of the right thing to do, some SMEs may remain reluctant to any action or compliance and still be in line with the values of stakeholders around the business (Pett et al., 17).

Stakeholders exert a great influence in the businesses behavior and are directly or indirectly affected by the environmental consequences of business activities', in many cases, with much larger effects than expected (Madsen and Ulhøi, 77). As suggested by Madsen and Ulhøi, stakeholders are "individuals or groups with a legal, economic, moral and/or self-perceived opportunity to claim ownership, rights or interests in a firm and in its past, present and future activities – or in parts thereof" (Madsen and Ulhøi, 78). In the case of small firms, the stakeholders usually are the owners, the employees, the neighbors, and the local communities, some of whom, according to the kin-based classification of businesses, may also act as customers, suppliers, or competitors.

The stakeholders' stake can be an interest, a right, and an ownership. In the case of kin-based businesses a number of interests may converge, such as the personal influence over the business, the ownership of a business branch, the social approval and acceptance within a community, or the concentration of power within the family.

A higher stake, such as avoiding the risk of possible harms to the own health, may mold the stakeholders' attitude and impose pressure at the firm level towards a change in the business behavior.

If so assumed, offences to employees' health and safety will be associated with a careless management and the application of a devaluated set of norms and values within the SME, where human health is not important. The society at large or the community in particular will then identify the SME behavior and will condemn these practices; the business will have to face the shame of the social disapproval. Only those societies willing to accept the burden of disease caused by environmental hazards will tolerate these businesses practices. Otherwise, it can be expected that the society will associate business compliance with health preservation, a frame that can be labeled as the right thing to do (Petts et al.20). The subsequent step is to transform a higher stake into an economically viable option for the firm.

The economic imperatives that govern the SMEs decision making process exert a great influence over attitudes and behavior, acting as a potent resistant force. A real and daily concern over costs tied with an increased pressure over the availability of economic resources, turns the SMEs' environmental variables into a neglected issue.

Given the interrelatedness and interdependency of the SMEs with its members and its markets, the power of public disapproval, embarrassment and shame from an unacceptable behavior may have a direct effect on the economic performance of the SME. A loss in access to markets or in funding sources may hit the firm, threatening the business continuity or survival. In addition, public pressure will not only have an effect in the business but in the whole network of people behind each SME. Public pressure can then be incorporated as a new driving force. Reinforcement for this new driving force can come from the regulatory framework.

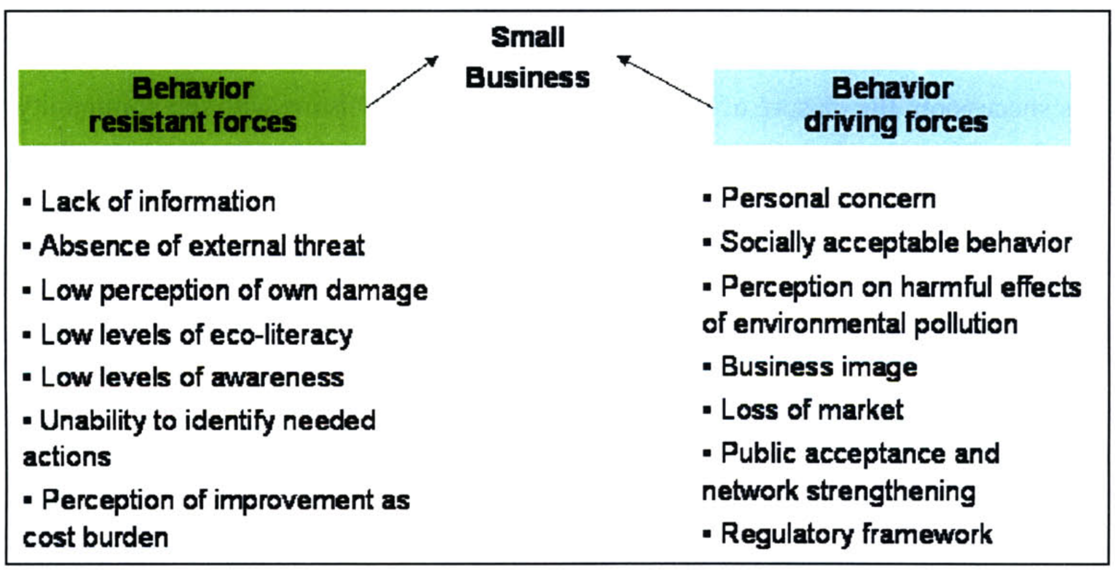

Figure 1: Resistance and driving forces for SMEs behavior

Conclusions

It is clear that SMEs have a social and environmental responsibility for its employees and neighbors. What is missing is how to transform the social acceptance or rejection derived from compliance or non-compliance into a driving force that fosters SMEs performance.

Understanding the differences and particularities between the three types of kinship-based firms, the value associated with kin relations, and the alternating managerial styles, greatly improves our understanding of the SMEs' dynamics.

As a network of relatives, friends or neighbors with a common culture, values, attitudes or history, SMEs assign great value to qualitative features such as the personal control over the business, the concentration of power, the inheritance to family members, the business succession, the closure of the network, the personal liaisons with the community, the shared values, and the recognition and support from the community. The business qualitative characteristics are explicitly demonstrated in the SME's organizational setup and decision-making process through nepotism or rules of the game that emphasize the personal influence within the SME.

As a result of these deliberate practices and selected set of values, SMEs develop a close network of trust that ensures a combination of incentives, effective monitoring and loyalty among its members, and generates a wealth concentration that remains sufficiently concentrated in the family that owns and controls the firm (Colli, Fernandez-

Perez, and Rose, 31 and 52). However, these economic results do not guarantee an improved environmental and health performance.

It is precisely at this point where the SME characteristics and dynamics as family or kinship businesses and the SME attitudes and behaviors towards the environment may converge.

Under the assumption that environmental hazards may lead to harm, societies may recognize a firms' unacceptable behavior by the harm caused on employees and neighbors derived from the business attitudes and behavior (Petts et al., 20).

The role that SMEs have in the society can be shaped by the social perception developed around an SME. Society will develop a perception of the firm according to the demonstrated business concerns and compliance towards their employees' health and the environment. Then, the society may approve and accept or disapproved and reject the business. This social response reinforces the behavior and role of the SME in its community. A virtuous circle is possible and can be supported by the shared values and existing kinship relations that keep the small business together and running.

Adjustments to the regulatory framework can be done in order to reflect the personal concerns and the expected firm's acceptable behavior. If the regulations are adjusted to jointly consider an improvement in environmental performance and a reduction on harmful effects on people, regulatory compliance can be related to social acceptance.

A drawback is the potential difficulty in convincing SMEs about their environmental impact. In order to reduce or avoid this drawback, the environmental compliance has to be related to something tangible at the firm level. A clean, safe and healthy working environment can be explored as an indicator and as a precursor of a business response to environmental standards.

Chapter 3: Environmental and Health Management: a definition.

Based on the possible and desirable convergence of environmental and health issues over the workplace, it is necessary to develop an environmental and health management model and framework suitable for SMEs.

A main concern when linking environmental and health management at the business level is the effect that work and workplace organization have on the worker's health (Shannon, Robson, and Sale, 319), at an individual or job level, or at the overall firm level. Workplace exposures cause or aggravate diseases as common and diverse as asthma or dermatitis, and diseases as important as ischemic heart disease, cancer, and chronic obstructive pulmonary diseases.

Few physicians are specifically trained to recognize or prevent occupational diseases; as a consequence, the association between occupational risks and disease may be missed (Newman, 1128). Fewer regulatory agencies, SMEs support programs, or SMEs owners and employees may assign any harmful effect to a specific environmental hazard.

Environmental and Health Management can focus on existent concerns, such as workplace safety, employee health, chemical substances management at workplace, workplace emissions, occupational exposure, disease prevention, or work-associated risk. Each of these concepts are studied and researched by a number of sciences and disciplines that range from Medicine, to Labor, and to Environment. Fields of knowledge such as Epidemiology, Occupational Health, Industrial Hygiene, or Environmental Management, among others, have overlapping concerns and interests that can converge in environmental and health standards or support programs directed to the small business sector. Their interaction may address various concerns, from the etiology of illnesses and disease at the workplace to the link between employee health and the organizational overall strategy.

Therefore, it is important and necessary to initiate the search for a model and a framework by defining and distinguishing the diverse fields of knowledge from the environmental and health arenas that converge at the firm level.

In order to understand their interaction, this chapter defines, describes and compares the approach that each science has in the environment and health relationship, and furthermore, proposes an integration model that could be used as a general framework for policy analysis and regulatory adaptation.

Overlapping concerns

Up to date, environmental management and health management have existed as two parallel worlds at the firm level. Nevertheless, "there is a growing interest in the benefits [derived from] integrating occupational and environmental health protection practices" (Enander, Gute, and Cohen, 313).

At least nine different fields of knowledge from the environmental and health areas converge at the firm level. The nine sciences considered in this thesis are: Occupational Health, Occupational Medicine, Industrial Safety, Industrial Hygiene, Environmental Health, Environmental Management, Epidemiology, Toxicology, and Risk Assessment.

Occupational Health

Occupational Health is defined as the prevention of illness and the promotion of health at the workplace (ABOHN, 2003). Among its activities, Occupational Health includes the detection of work and workplace hazards, evaluation of regulatory compliance, and counseling crisis intervention (ABOHN, 2003). Practitioners of Occupational Health have among its functions the following: (1) health supervision of employees, (2) pre-placement health assessment, (3) routine health assessment, (4) health education, (5) environmental surveillance, (6) employee counseling, treatment and rehabilitation, and (7) record keeping of employee health data. It is also expected that occupational health professionals are able to identify hazards at the workplace, such as exposure to infections, chemicals, allergens, irritants, and hazardous waste (Dixon, 1984).

Health effects are generally presented using any of two measures: mortality, as the number of deaths per unit of population per unit of time, and morbidity, as the number of non-fatal cases of reportable disease.

Occupational Medicine

Occupational Medicine, as a branch of Clinical Medicine, is equivalent to Preventive Medicine at the workplace. Its aim is to promote and maintain the highest possible degree of physical, mental, and social well being of workers at the workplace in any occupation (SOM, 2004). The background of Occupational Medicine practitioners is Medicine. In addition to their medical training, it is expected that they have knowledge and skills in Biostatistics, Epidemiology, health services management, control and prevention of adverse environmental factors, control and prevention of adverse occupational factors, and clinical preventive medicine. (ABPM, 2004)

Industrial Safety

Industrial Safety is defined as the prevention of accidents, incidents, and injuries that harm people, property, or the environment in the workplace (La Dou, 12; CSP, 2002). According to the Board of Certified Safety Professionals, a Safety Professional is able to anticipate, identify and evaluate hazards, their likelihood of occurrence, the expected severity of results, the associated risk, and the derived costs for the company (CSP, 2002). Therefore, they shall design, develop, and implement correspondent hazards controls as part of their work (CSP, 2002).

Safety Professionals have knowledge on industrial hygiene, toxicology, fire protection, ergonomics, physics, chemistry, psychology, industrial processes, environmental safety and health, environmental regulations, and statistics, and may specialize in Industrial Hygiene, Environmental Safety, or Risk Management (ASSE, 2000; CSP, 2000).

Among their responsibilities in a firm, Safety Professionals are in charge of regulatory compliance, hazardous materials management, environmental protection, fire protection, and health hazard control (CSP, 2002).

Industrial Hygiene

Industrial Hygiene, also known as Occupational Hygiene, is defined as the "anticipation, recognition, evaluation and control of those environmental factors and stresses arising in or from the workplace" (ABIH, 2003). An Industrial Hygienist is concerned with the physical conditions of the environment in the workplace and the protection of employees' health and well-being (AIHA, 2000). It is expected that the technical knowledge of an Industrial Hygienist includes the following areas: "basic science; biohazards; Biostatistics and Epidemiology; engineering controls; non-engineering controls; Ergonomics; ethics and management; Analytical chemistry; sampling, monitoring and instrumentation; noise and vibration; ionizing radiation; nonionizing radiation; regulations, standards, and guidelines; thermal and pressure stressors; toxicology; and general IH topics including community exposures, hazardous wastes, risk communication, process safety, indoor environmental quality, and others" (ABIH, 1998)

Part of the Industrial Hygienist labor is the recognition of "stresses arising out of industrial operations and processes" (Anton, 144). The exposure limits, measured as Threshold Limit Values (TLV), Maximum Allowable Concentrations (MAC), Workplace Environmental Exposure Limits (WEEL), Recommended Exposure Limits (REL), or Occupational Exposure Limits (OEL) are the primary tools used to such end.

Environmental Health

Environmental health is a branch of the general science of public health. It can be defined as the assessment, understanding, and control of human impacts on their environment and the impact of environmental hazards in the human (Moeller, 1), or as the safeguard people's health from environmental hazards (CDC, VII, 2002). Overall, environmental health deals with human health at the population level and focuses on the interactions between people and the public exposure to environmental hazards present in the atmosphere or the biosphere. The main emphasis is on the prevention, reduction, and control of environmental threats or hazards.

According to the United States National Center for Environmental Health, an environmental health professional should be able to "anticipate, identify, and respond to environmental exposures and the consequences of these exposures to human health" (NCEH, 2004).

A variety of topics may be addressed by environmental health, from water-borne diseases to indoor and outdoor air pollution, or from emergency responses to earthquakes and floods to children lead poisoning.

Environmental Management

Environmental management has been defined by a number of institutions and programs around the world. In essence, refers to the overall management function including planning and implementation of specific actions that lead to an improvement in the quality of the environment and to the development, achievement, and maintenance of environmental policies and objectives. Being a comprehensive and, at the same time, a general definition, environmental management may include audits, manuals, systems, standards, or reviews.

From a business perspective, a firm should assess its environmental impacts, set targets to reduce those, and establish an action plan to achieve the targets. Along the way, an improvement in processes and in operations is expected. As recommended by environmental management systems standards, a wide and decide support from the top management is an important element for the improvement. The support is expressed as human and financial resources devoted to the accomplishment of established targets and activities as well as for review of the overall achievements and the redefinition of the targets or actions.

In concept, environmental management may embrace diverse business guiding principles such as triple bottom line or corporate social responsibility; business tools such as cleaner production, waste minimization, eco-efficiency, pollution prevention, or design for the environment; and business standards, such as ISO14001, EMAS, SA8000, life-cycle assessment, or total quality environmental management (BSDGlobal, 2002).

Table 4: Environmental management principles and tools

Business guiding principles	Business tools	Business systems and standards
• Corporate Social Responsibility • Triple bottom line • Business charters for sustainable development • CERES principles	• Cleaner production • Waste minimization • Pollution prevention • Eco-efficiency • Design for the environment	• ISO14001 • EMAS • SA8000 • Life-cycle assessment • Total quality environmental management • Environmental reporting

Management tools, although useful for a number of SMEs, have not proved their overall applicability to the totality of SMEs. This inapplicability is linked to the differences in organizational structure and management style among larger firms and SMEs, and to the peculiar or particular characteristics of the former ones.

A major barrier in the environmental management field is that most of the guiding principles, tools, and standards were designed with a central focus on large companies. Although different efforts to apply the methodologies to small firms have been done, the SMEs ability to respond to environmental problems using these methodologies is limited. Lack of technical knowledge, lack of awareness of the benefits, high cost of implementation, or even resistance to change appear as resistance forces on the environmental management effort (Tilley, 239; Revell and Rutherfoord, 27; Friedman and Miles, 324).

Epidemiology

Epidemiology is defined as "the study of the distribution and determinants of disease frequency in human populations" (MacMahon and Trichopoulos, 1). Through studies on populations and statistical interpretations, epidemiologists measure the disease outcomes in a target population usually defined as population at risk.

The two most common measures used by Epidemiologists for disease frequency are incidence and prevalence. The incidence (or frequency) of a disease is the rate at which new cases occur in a population during a specific period of time, while the prevalence of a disease is the proportion of a population considered as cases (having the disease) at a point in time (Coggon, Rose, and Barker, 1997; MacMahon and Trichopoulos, 43).

Measures of association, such as attributable risk or relative risk, are used to compare disease rates between populations who have different levels of exposure to a risk factor. In an occupational setting, Epidemiology may help identify occupations with high risk to a specific disease and the agents to which individuals in these occupations are exposed, i.e solvent emissions or heavy metals in printing industry.

Epidemiological studies may rely on the World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD-10) as a tool for classification and comparison among studies in different populations and parts of the world.

Toxicology

Toxicology is the study of the harmful pathological, biochemical, and physiological interactions between chemicals or physical agents and biological systems (Timbrell, 1; NLM, 2001). The agents of interest for Toxicology are those that may cause an effect on the entire body of a human being or in specific tissues or organs, i.e. the central nervous system, the liver, or the connective tissue.

Toxicology studies the effects produced by a dose and the likelihood of an adverse response from changes in that dose. As a result, information about the dose-response relationship can be obtained, as well as data for tolerance to the substance, human susceptibility, possible effects from interaction with other substances (additive, antagonistic, potentiating, or synergistic effects), timing (acute or chronic, latency, reversibility), threshold limits for the substance, and the toxicity mechanisms within the human body, as exemplified in Figure 2.

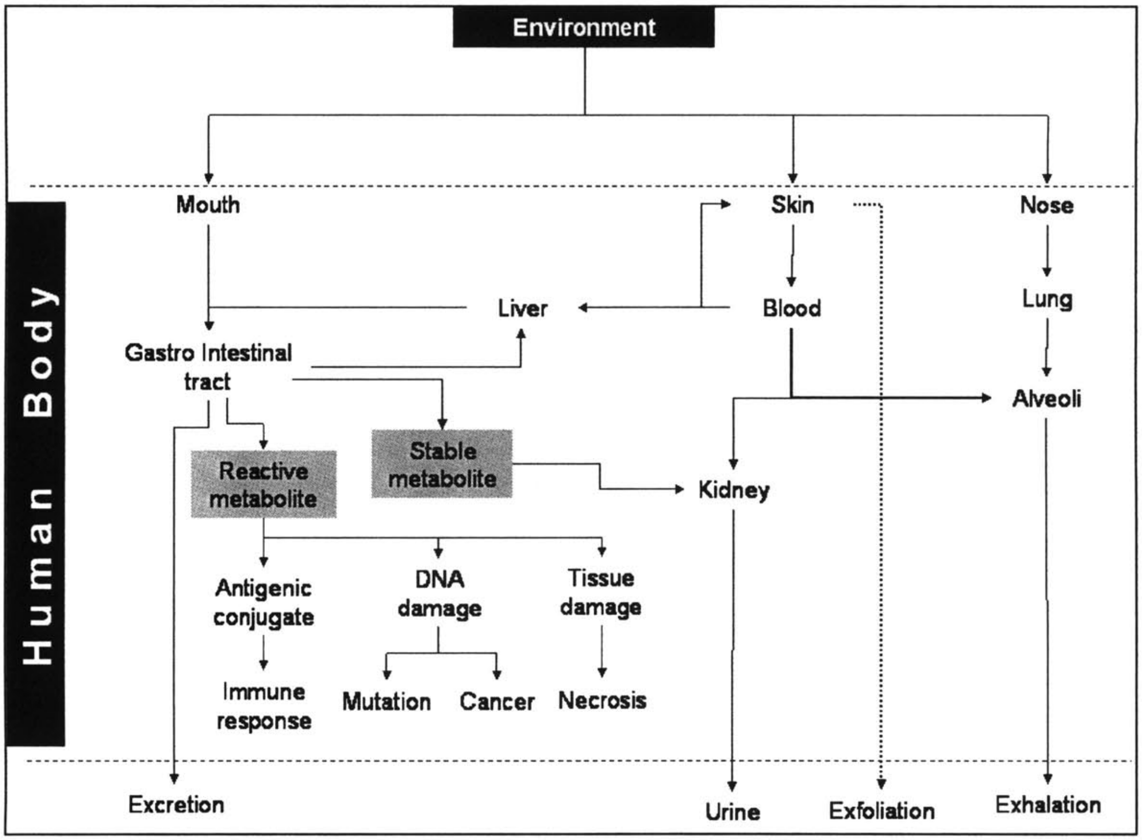

Figure 2: Metabolic pathways of an exposure

Toxicity of chemical substances is usually determined via toxicity studies that are initially conducted with animals. Once that information about carcinogenesis, reproductive toxicity, teratogenesis, neurotoxicity and immunotoxicology is gathered, extrapolation of animal data for responsiveness and biological effects is performed. Later on, exposure limits for human populations are established.

A variety of measures are used for exposure limits: reference dose (RfD), no-observed-adverse effect level (NOAEL), lowest-observed-adverse effect (LOAL), and the no-adverse-effects level for humans ($NAEL_{human}$).

Risk Assessment

Risk assessment can be defined as the "characterization of the potential adverse health effects of human exposure to environmental hazards" (NRC, 18) or as the process that estimates the "likelihood of undesirable effects resulting from exposure to a chemical" (Timbrell, 173). As a process, a risk assessment includes the participation of many established scientific disciplines (NRC[6], 84): Biostatistics, Carcinogenesis, Toxicology, Pathology, Physiology, Epidemiology, Genetics, Medicine, Nutrition, Biochemistry, and Teratology, among others (NRC[7], 89).

In essence, a risk assessment combines human data, animal bioassay data, and data from other sources to estimate the quantitative and qualitative risk level derived from exposure of a given population to a natural or synthetic chemical compound. The process of risk assessment is usually broken down into four components, as shown in Table 5:

Table 5: Risk assessment components

Component	Definition
Hazard identification	Identification of whether a particular chemical can cause an adverse health effect in humans
Dose-response assessment	Characterization of the relationship between dose received and severity of an adverse health effect in the exposed population
Exposure assessment	Quantification of the amount of chemical to which humans are exposed
Risk characterization	Prediction of frequency and severity of effects in exposed population

[6] NRC. (1999). Strategies to Protect the Health of Deployed U.S. Forces. Assessing Health Risks to Deployed U.S. Forces. Workshop Proceedings. National Academy Press. USA. p. 84.
[7] NRC (1983). Risk Assessment in the Federal Government: Managing the Process Working Papers. Commission on Life Sciences. National Academy Press. USA. p. 89.

1) Hazard identification.

Hazard identification is the first step of a risk assessment and is commonly conducted by evaluating the toxic potential of a chemical (Timbrell, 174) and determining if the chemical can cause an adverse health effect in humans (Beck, Rudel, and Calabrese in Hayes, 26). Four main sources of data are used: animal studies data, data on in vivo or in vitro studies, epidemiologic data, and data derived from analogies on chemical reactivity and molecular structure.

Animal bioassays are based on the premise that mammalian animal bioassays are predictive of potential adverse health effects in humans (NRC, 34). During bioassays, groups of animals are exposed throughout their lifetime to a maximum tolerated dose (MTD) or to half the MTD, and are later compared to the control group of unexposed animals (Beck, Rudel and Calabrese in Hayes, 30). Assays generate information regarding identification of potentially sensitive target organs, embryonic and fetal lethality, specific types of malformations, reproductive effects, and multigenerational effects, among others (NRC, 34).

In addition to animal bioassays, epidemiologic studies are used to identify "a positive association between an agent and a disease" (NRC, 20). As a result of this first step, a scientific judgment based on evidence is emitted, indicating whether or not the chemical under study can cause a particular adverse health effect in humans (Beck, Rudel, and Calabrese in Hayes, 26). Commonly, positive and negative evidence is further used by regulatory agencies to prepare classification schemes of carcinogens. Each agency may use the weight-of-evidence (positive and negative evidence) or the strength-of-evidence (only positive evidence) collected to such purpose (Beck, Rudel, and Calabrese in Hayes, 31).

2) Dose-response assessment.

Dose-response assessment quantifies the "hazard already identified and estimates the relationship between the dose and the adverse effect in humans" (Timbrell, 175). The relationship characterizes dose with the severity of an adverse health effect and "should be established at exposure levels to which humans are most likely to be exposed" (Beck, Rudel, and Calabrese in Hayes, 34).

A variety of methods are used in dose-response assessment including pharmacokinetic and pharmacodynamic models, physiological based pharmacokinetic models, extrapolation to low doses via mathematical models, or cross-species extrapolation, among others.

The dose-response assessment provides information on the intensity of exposure, the relationship between concentration and time, the metabolism of a chemical at different doses, the persistence over time, and the existence of a threshold for the chemical (Beck, Rudel, and Calabrese in Hayes, 27). Also, dose-response assessment generates information for the classification of chemicals compounds as carcinogens[8].

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[8] Beck, Rudel, and Calabrese in Hayes provide a table showing chemicals, industrial processes, and environmental factors associated with cancer induction in humans. See: Beck, B. Rudel, R., Calabrese, E.

3) Exposure assessment.

After the dose-response assessment or simultaneously, an exposure assessment is performed. The main role of exposure assessment is to identify and quantify the dose at which the population or the individuals are exposed. From an exposure assessment it is possible to know if people are currently exposed to any chemical compound or pollutant, to identify the possible pathways and routes followed by the substance from the environment into the body, and to estimate the actual duration and frequency of the exposure (Timbrell, 177; Beck, Rudel, and Calabrese in Hayes, 27).

Exposure assessment includes the detection of agents, the assessment and monitoring of concentrations, the collection of samples, the collection of information about the chemical agent, the measurement of the exposure timescale, the duration of exposure, and the determination of routes of exposure. Exposure biomarkers such as blood, urine, hair, or specific metabolites may be used as "indicative of delivered toxicant doses" (NRC, 8[9])

"The Use of Toxicology in the Regulatory Process" in Hayes, W. (1994). "Principles and Methods of Toxicology". Raven Press. USA. pp. 33.

[9] NRC. (2000). "Strategies to Protect the Health of Deployed U.S. Forces". National Academy Press. USA.

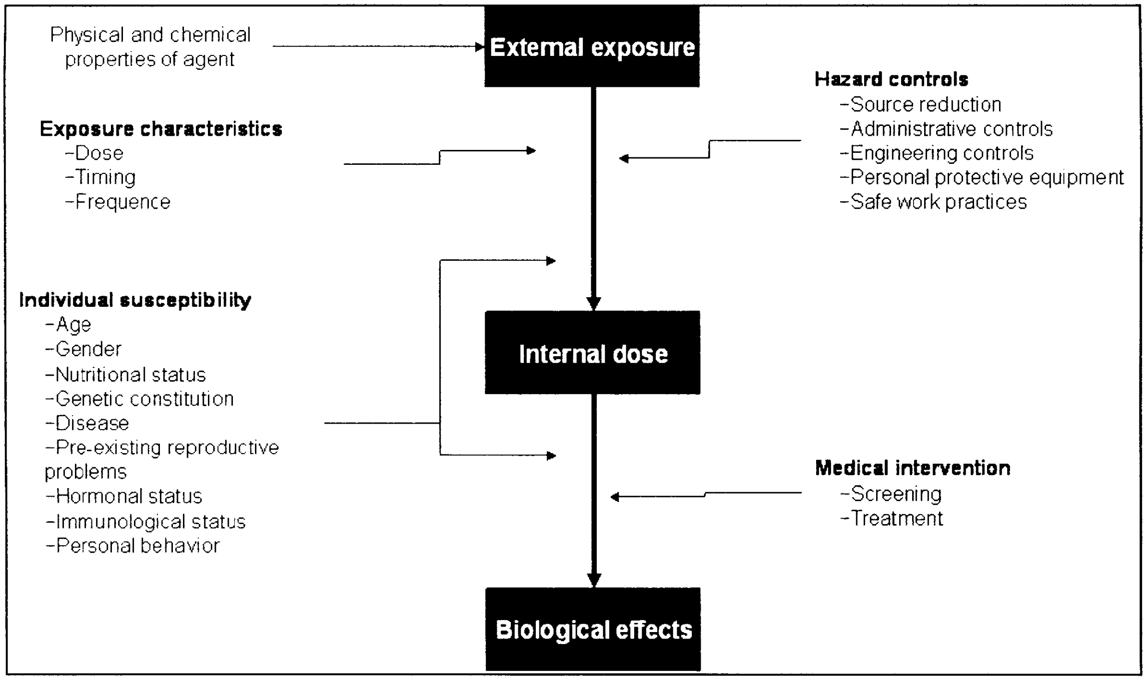

Figure 3: Exposure assessment and factors that influence response to toxicants[10]

4) Risk characterization.

Risk characterization is the final step of the risk assessment process; thus integrates the information generated in the preceding steps and estimates the probability of occurrence of the adverse effects in humans (Timbrell, 177). Risk characterization involves "a prediction of the frequency and severity of effects in the exposed population" (Beck, Rudel, and Calabrese, 27). The result is expressed as a single number that represents an increased risk of developing a disease (i.e. lung cancer of one in a million).

The resultant risk may differ by different orders of magnitude according to the susceptibility of individuals and the population, or the uncertainties included as part of the risk characterization process, like safety factors, measurement errors, extrapolation from subchronic to chronic exposure, or from extrapolation from a LOAEL to a NOAEL.

[10] Adapted from Derelanko, 1006.

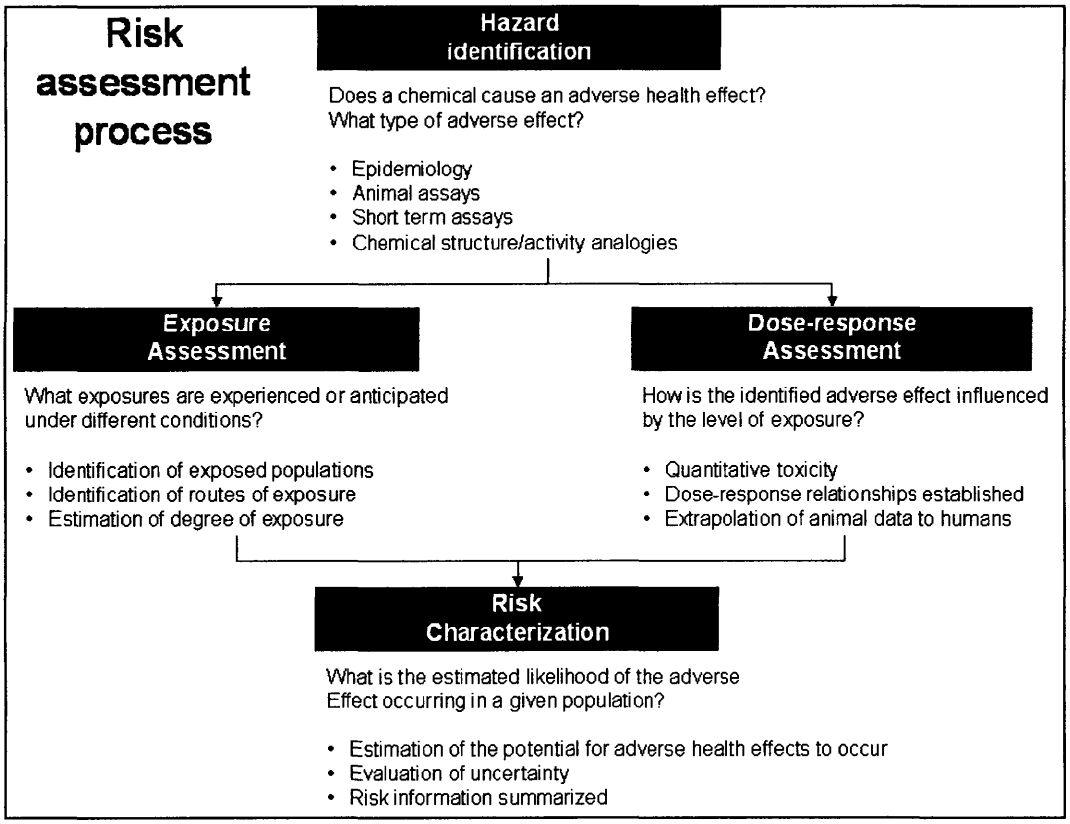

Figure 4: Risk assessment process[11]

Upon completion of the risk assessment process, a series of risk management decisions take place, including the establishment of exposure limits, the prioritization of health outcomes, the classification or risk agents, or the development of health monitoring programs.

Regulatory agencies use risk assessment to set priorities over the substances that should be selected for serious regulatory review and to determine appropriate policy measures required to protect public health (NRC, 112).

[11] Adapted from Derelanko, 1004

Despite what the risk characterization establishes, the perception of a risk may be modified by diverse factors (Table 6). A modified perception may be equally present among small firms and policymakers.

Table 6: Factors that influence risk management decisions

Perception of low risk	**Perception of high risk**
Assumed voluntarily	Borne involuntarily
No alternatives	Safer alternatives available
Exposure is essential	Exposure is a 'luxury'
Occupational exposure	Non-occupational exposure
Average individual	Susceptible individual
Intended use can be reasonable guaranteed	High potential for misuse
Reversible toxic effect	Permanent toxic effect
Non-inheritable	Inheritable
Perceived as acceptable risk	Perceived as unacceptable risk

As shown in Table 7, a diversity of psycho-social and cultural behavior also affect the individuals perception of any risk.

Table 7: Psycho-social and cultural caracteristics affecting perception of risk[12]

Perception of low risk	**Perception of high risk**
Voluntary	Involuntary
Familiar	Unfamiliar
Immediate impact	Remote impact
Detectable by individual	Non-detectable by individual
Controllable by individual	Uncontrollable
Non-catastrophic	Catastrophic
Well understood	Poorly understood
Natural	Artificial
Trusted source	Untrusted source
Visible benefits	No visible benefits

[12] Adapted from Lippmann, 907.

The overlap of interests and concerns among many disciplines may provide a useful framework that modifies the common (mis-)perception of the harmful effects caused by environmental hazards (Figure 5). Four fields of knowledge explicitly emphasize the prevention of illnesses and disease as their main activity; their actions include the detection of environmental hazards at the workplace, exposure assessment, health assessment, review of regulatory compliance, and education and promotion of well being. These four fields of knowledge are Occupational Health, Occupational Medicine, Industrial Safety, and Industrial Hygiene; the first three respectively work on the individual and the fourth on the physical conditions of the workplace.

Four more fields of knowledge have an emphasis on primary and secondary prevention. These are Occupational Health, Environmental Health, Environmental Management, and Risk assessment. As part of their activities they assess the harmful effects of environmental hazards or the changes in environmental conditions at the workplace. Their work is preventive and also incorporates the identification of people with an established disease.

Two fields stand by itself and share concerns with the other seven fields of knowledge. These two fields are Toxicology and Epidemiology. Both differentiate from the rest because of their particular approach to the health effects of environmental hazards. In the case of Toxicology, its activities are mainly performed previous to the occurrence of exposures in the workplace and have a main role in defining the likelihood of any adverse effect. On the other hand, Epidemiology analyses the etiology and distribution of the diseases once they occur. Epidemiologic studies go back in time to test hypothesis for populations at risk.

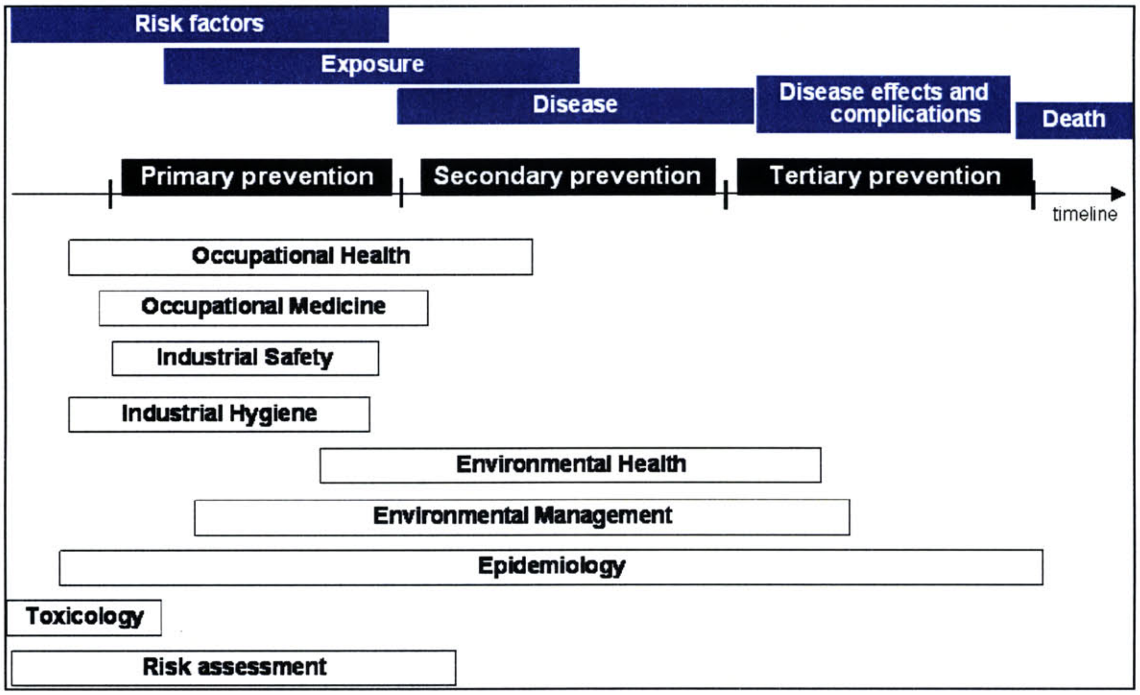

Figure 5: Overlap of interests and concerns

The framework for the Figure 5 comes from the Medical field, where human health is taken care by primary, secondary, and tertiary prevention activities. Primary prevention provides measures to avoid a health problem. These measures include the education of people about risk factors and lifestyle changes to reduce risk, surveillance of exposures, control of hazards in the workplace, and the identification and alteration of risk factors to prevent disease. Secondary prevention focuses on early identification of people with an established disease or with a high risk of developing a disease, and their treatment to reverse, prevent, or slow the progression of the disease (Rudolph, Deitchman, and Devin, 308); preclinical screening tests may be used to confirm the disease. Tertiary prevention cares of established disease and further attempts to minimize the negative impacts of disease and to prevent disease-related complications.

A model for Environmental and Health Management

The different approaches for each of the sciences described in this chapter have a specific approach and interaction at the firm level. Medical, environmental, labor, and safety approaches converge at the workplace. Figure 6 shows an interaction model prepared by the author.

The tri-circle diagram commonly used to schematize the definition of sustainable development and to represent the interactions of economy, environment, and society is taken to exemplify the environmental and health management convergence at the firm level. Based on this diagram, three main components comprise the environmental and health management model: the health conditions at the workplace, the job definition at the workplace, and the environmental conditions at the workplace.

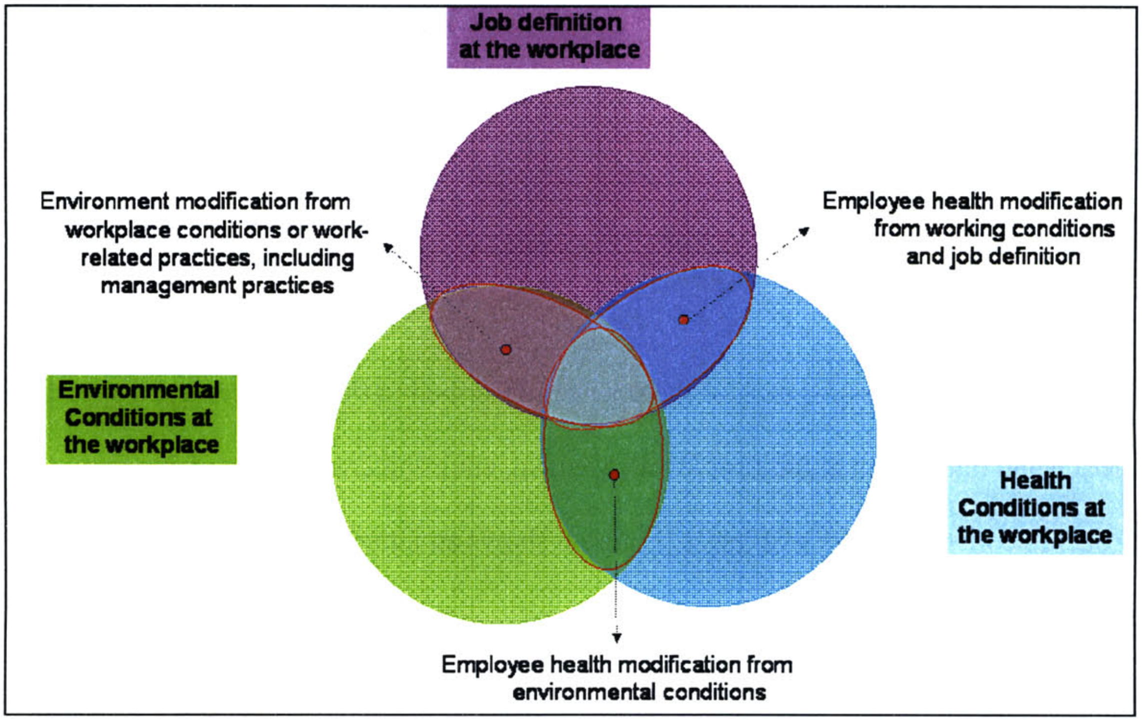

Figure 6: Interaction between environmental, health, and working conditions

The job definition represents the perspective of the firm. Under this sphere, each firm defines the activities to be performed for each job position (i.e. clerk, machine operator, treasurer, laboratory analyst). By doing so, a general description for the job may be obtained per industrial sector (i.e. printing machine operator in the printing industry); at the same time, each firm defines its own plant distribution, establishes its processes sequences, builds or modifies the necessary infrastructure, selects its personnel, and provides the specific job position with the necessary tools to perform its duty, including any protective equipment.

The health conditions refer to the person in particular. Viewed from the point of view of the firm, health conditions refer to employee. Each employee has a personal health profile determined by living habits, nutritional intake, disease or injury susceptibility, exercising frequency and intensity, and genetic preconditioning. As an employee, each person brings its own health profile to the workplace. This individual profile may be altered according to the type of activities to be performed as part of the job and according to the conditions of the environment around the person.

The environmental conditions refer to the indoor and outdoor conditions around the employees and the firm. Meteorological, climate, or air conditions may shape and modify the environmental conditions at the workplace. However, these conditions may also be modified by the activities performed within the firm, the employees' actions and habits, and the control or prevention measures that the firm has in place. Consequently, emissions that come from raw materials, originated by the physical or chemical properties of the material or by their handling, management, use, or misuse at the workplace may change the indoor environmental conditions.

These three conditions are then represented by three overlapping circles. Table 8 includes examples of the incidents or situations that may exist when environmental, health, and work-related conditions interact and overlap.

Table 8: Interactions between environmental, health, and working conditions

	Causative Agents		
Effects	**Environmental conditions**	**Health (employee) conditions**	**Job (work) conditions**
Environmental conditions		Employee practices provoke emissions or waste generation.	Modification of environmental conditions from job related practices or from workplace conditions i.e. increase of humidity and concentration of emissions because of lack of ventilation systems
Health conditions	Alteration of employee health from exposure to environmental conditions i.e. solvents		Alteration of employee health from job conditions i.e. dangerous conditions of electrical system, lack of protective equipment, inventory management
Job conditions	Excessive concentration of emissions in indoor air	Use or misuse of protective equipment.	

According to their own approach to the environment, health, and work-related conditions, each one of the nine fields of knowledge previously described may be incorporated into the tri-circle model as shown in Figure 7. From this figure is possible to appreciate the different approaches followed by the analyzed fields of knowledge. Industrial Safety, Occupational Health, Occupational Medicine and Epidemiology have a major emphasis on the interaction between working conditions and employee's health conditions. Risk assessment, Toxicology, Environmental Health, and Industrial Hygiene address the interactions between environmental conditions at the workplace and the effects on human health. Environmental Management practically stands alone in analyzing the effect of the workplace conditions on the environment.

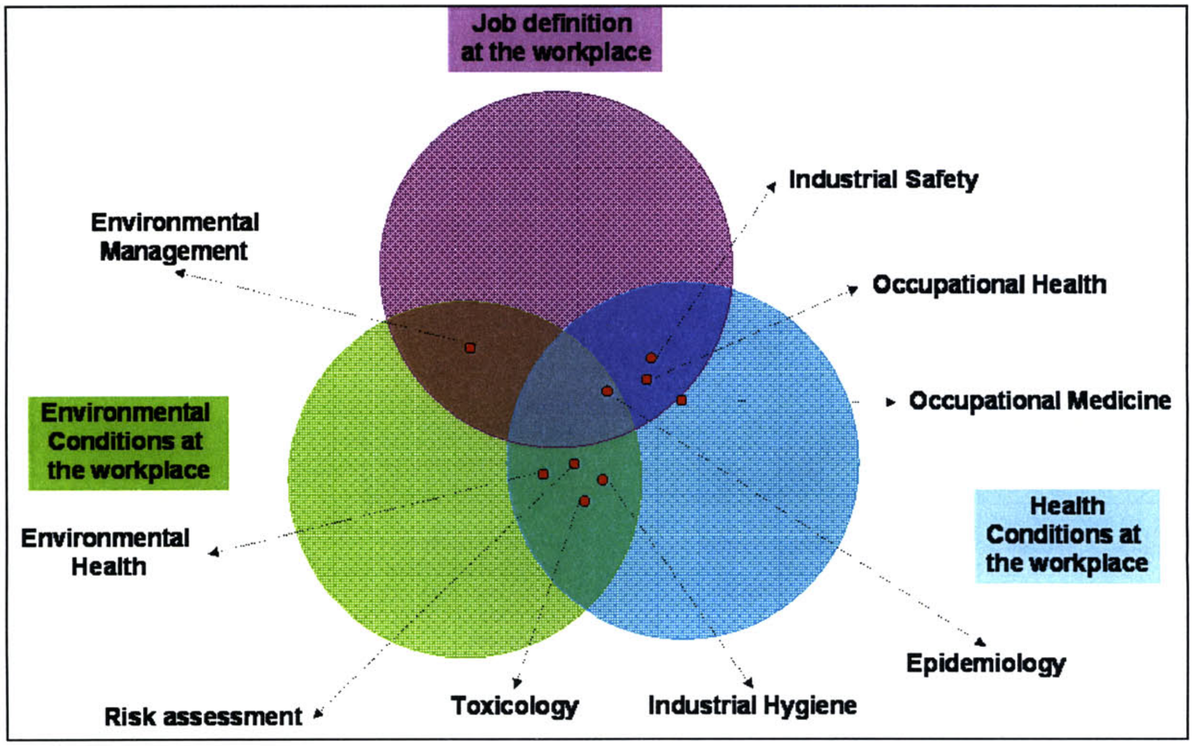

Figure 7: Interaction of fields of knowledge at the firm level

However, in this milieu of sciences and expertise, a convergence of environmental and health management begins to appear; i.e. from known or estimated exposures, toxicological information, and possible health effects, environmental measures such as source reduction, environmental management, ecoefficiency, pollution prevention, waste minimization, or cleaner production, can be taken to reduce or eliminate risk factors and disease outcomes (Figure 8). A complete example from the printing industry may be explained to exemplify the convergence.

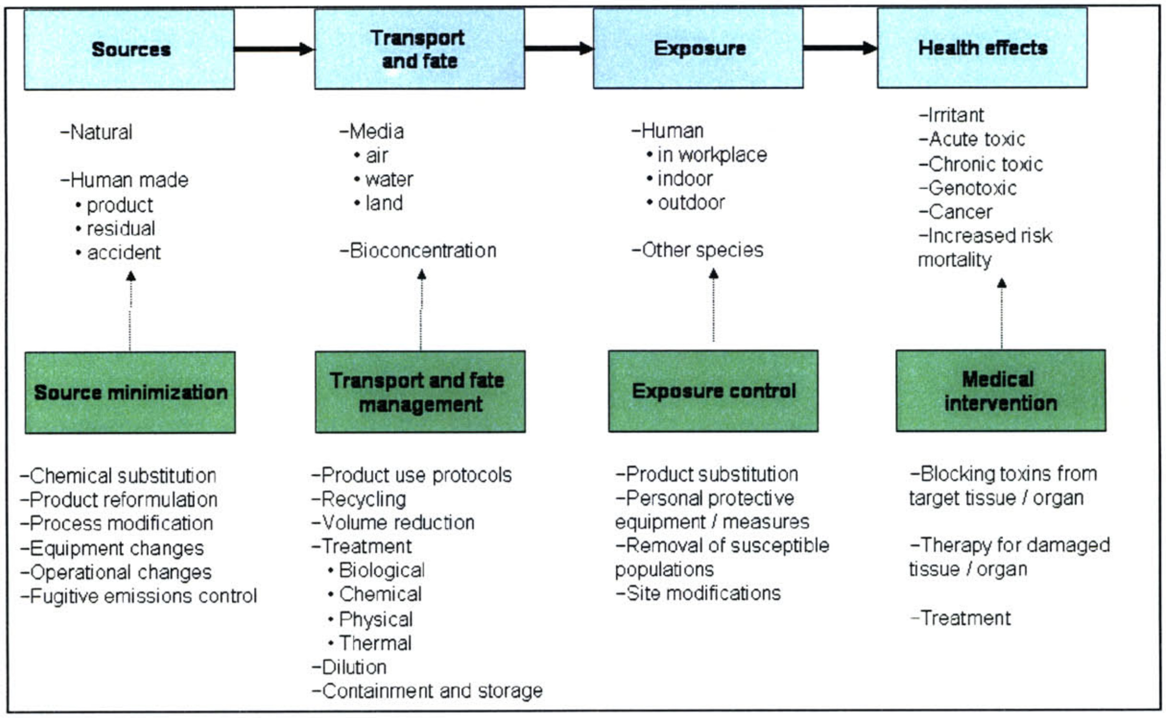

Figure 8: Environmental and health management-reduction of environmental risk to human health[13]

An example from solvent-related disorders

A comprehensive example of the need for an integrated approach to environmental and health management can be taken from Xiao and Levin [2000]. In their study, the authors review the diagnosis, management, and prevention of solvent-related disorders.

As part of their approach, an iterative six-steps process is followed: (1) the identification of solvents used in the workplace; (2) the description of possible routes of exposure; (3) the metabolism of the solvent and the formation of metabolites; (4) the review of acute

[13] Adapted from Upton in Lippmann, 917.

and chronic health effects; (5) the clinical evaluation of solvent-related disorders; and, (6) the workplace assessment of solvent-related disorders.

A first step is the identification of solvents used in the workplace. Each industrial sector has a deep knowledge on the most commonly used substances including solvents. Information on solvents use can be obtained directly from firms in a specific industrial sector or by their traders associations or industrial chambers; additional information can be obtained from governmental toxic releases inventories, sector-specific regulations, emissions permits or waste generation records, or by firm records generated from environmental management systems.

As a second step an assessment of the possible routes of exposure is performed. Exposure assessments, epidemiologic studies, industrial safety measures, industrial hygiene conditions, environmental health considerations, and occupational health measures or studies may be used as sources of information. The assessment determines the intake route (via inhalation, ingestion, or skin contact), the concentration at which the employees are exposed, the duration and frequency of the exposure, and the firm's handling and management practices for the solvent under study.

The third step determines the biotransformation processes and the routes of elimination or accumulation. Environmental and biological sampling may be used to confirm the solvent intake. Dose-response assessments, exposure assessments, or toxicological studies are possible sources of information.

As a fourth step, a review of the health effects is performed. Acute and chronic effects in the Central Nervous System, Peripheral Nervous System, renal system, liver, cardiovascular system, dermal effects, mucous membrane irritation, reproductive and developmental effects, or carcinogenicity are some of the possible identified or known diseases. In this step, epidemiologic studies, occupational medicine records, clinical interventions records, or risk assessment assumptions may be considered.

In the fifth step a full clinical evaluation of the solvent-related disorder is conducted. From a secondary or tertiary prevention perspective, the clinical evaluation determines the presence of an illness or disease. Information on occupational exposure history, past medical history, physical examination, and laboratory testing may be gathered or collected at this step. Afterwards, secondary and tertiary prevention activities are executed. At the firm level, the clinical evaluation prepares recommendations on exposure control or medical treatment. Specialists and professionals on occupational health, occupational medicine, industrial hygiene, environmental management, environmental health, and industrial safety use the information to control and correct workplace and environmental conditions.

As a result, a number of workplace measures are taken, from process modifications, products reformulation, materials substitution, or the provision of protective equipment, to an environmental and biological monitoring, or additional activities for exposure control. Overall, the firm identifies the need for reducing pollutants generation and the need to limit, reduce, or eliminate exposure. An increase in worker protection may be expected. An overall achievement is a risk reduction of solvent-related disorders.

Appropriate clinical consultation and work-site investigation can lead to effective primary or secondary prevention. Improvement in information collection about the patient's work history and history of exposure may improve availability of information. The use of standardized questionnaires, textbooks, or electronic databases (Table 9) may be used by physicians and policymakers to determine the most commonly recognized environmental risks or causes of the disease. At the workplace, Material Safety Data Sheets (MSDS) are a necessary tool for the Occupational Physician or Industrial Hygienist. Another useful source of information is the International Statistical Classification of Diseases and Related Health Problems.

Table 9: Environment and health electronic databases[14]

Database	Topics covered	Update frequency
Enviroline ®	Waste reduction, recycling and reuse, radioactive waste, bioremediation, toxicology, safety, pollution control, regulations.	Monthly
CAB ABSTRACTS (50 / CABI)	Recycling and reuse, radioactive waste, bioremediation, toxicology, safety, pollution control.	Monthly
NTIS (6 / NTZZ)	Waste reduction or disposal, recycling and reuse, radioactive waste, toxicology, safety, pollution control.	Weekly
Hazardous Substances Data Bank (HSDB)	Chemical substance name, CAS® Registry Number, controlled adverse effects, regulations	Quarterly
Registry of Toxic Effects of Chemical Substances (RTECS®)	Chemical substance name, CAS® Registry Number, controlled adverse effects, regulations	Quarterly
Occupational Safety & Health (NIOSHTIC®)	Controlled adverse effects, waste management, regulations	Closed
Toxfile	Chemical substance name, CAS® Registry Number, controlled adverse effects, waste management, regulations.	Weekly
Toxline	Toxicological, biochemical, pharmacological, physiological effects of chemicals	

[14] Extract obtained from the U.S. National Library of Medicine and from Thomson Dialog Search Aids. http://support.dialog.com/searchaids/smarttools/environ/environment2004.pdf

Occupational diseases classification: ICD-10

Occupational diseases are the result of a "combination of a disease and an exposure, as well as an association between these two" (WHO, 1). Different classification systems of occupational diseases have been used over time in an effort to standardize the surveillance and notification of labor health and safety and to increase the comparability of occupational diseases statistics (WHO, 2).

The International Statistical Classification of Diseases and Related Health Problems is used as a standard classification system of diseases for coding death certificates and for the registry of diagnostic or general reports in hospitals. The World Health Organization (WHO), responsible for its publication and update, performs periodic revisions to the system in order to keep it up to date with the medical advances.

Under the International Statistical Classification of Diseases and Related Health Problems on its 10th revision (also known as ICD-10), the WHO prepared a guideline for the notification of occupational injuries. The document includes the ICD-10 code for the disease, the name of the disease, the typical causative agent for each disease, and some examples of typical occupations and industries where exposure to the agent may occur. Table 10 shows a selection of some of the diseases included in the guideline. Although a disease cannot be directly or uniquely attributed to the causative agent, the presence of the agent and the workers exposure to this agent in the workplace presents a potential risk for the development of the disease.

Table 10: ICD-10 in Occupational Health[15]

ICD-10 Code	Disease	Agent	Occupation/Industry
C22	C22.3 Angiosarcoma of liver	Vinyl chloride monomer	Manufacturing of vinyl chloride, vinyl chloride polymerization industry
C34	Malignant neoplasm of bronchus and lung	Chromium IV compounds Nickel compounds Bios-(chloromethyl) ether	Chromium producers, metal plating, dye/pigment manufacturing Nickel smelting and refining, stainless steel production, manufacture of batteries Chemical industry
C67	Malignant neoplasm of bladder	Aromatic amines	Rubber and dye workers
D64	D64.2 Secondary sideroplastic anaemia due to drugs and toxins	Lead	Lead and zinc mining industry, construction industry, plumbing, accumulator plants, manufacture of ceramics, welding and cutting
F06	F06.7 Mild cognitive disorder	Lead Organic solvents	
G62	G62.2 Polyneuropathy due to other toxic agents	Acrylamide Carbon disulphide	Plastics industry Rayon manufacturing, rubber
G92	Toxic encephalopathy	Solvents	Occupations with exposure to solvents
H26	H26.8 Other specified cataract	Naphtalene	Chemical industry
J26	J26.0 Pneumoconiosis due to talc dust	Talc	Talc processors, soapstone mining-milling, cosmetics industry
J45	J45.0 Predominantly allergic asthma J45.1 Non-allergic asthma J45.8 Mixed asthma J45.0 Asthma, unspecified	Variety of chemical substances. Example: Isocyanates Flour ad grain dust Persulfates	 Chemical work, spray painting Baking, farming Hairdressers
K71	Toxic liver disease	Carbon tetrachloride	Dry cleaning

[15] Extracted from: WHO. (1999). "International Statistical Classification of Diseases and Related Health Problems (ICD-10) in Occupational Health". Geneva. WHO/SDE/OEH/99.11

Regulatory framework

The regulatory framework is perceived as a standardized, independent, and more equalitarian approach to environmental and health compliance, rather than self-regulation. Both approaches, the government generated regulation and the industry self-regulation, have advantages and disadvantages as shown in Table 11.

Table 11: Advantages and disadvantages of environmental regulation and self-regulation[16].

	Advantages	**Disadvantages**
Government generated	Independent	Expensive to monitor
	Publicly accountable	Requires expertise
	Standardized	Requires full complement of competent officials
	Equalitarian	Difficult to enforce
Self-regulation by industry	Encourages peer pressure	Confusing or vague guidelines
	Devolves monitoring costs to companies	Lacks of credibility
	Devolves compliance responsibility to companies	Relies on good faith of companies
		Presence of free-riders

From an ethical perspective, "small firms [will] need to become more aware of their environmental values and be better able to articulate this in their business culture" (Tilley, 243). SMEs will not only need to show willingness but actually will have to acquire the necessary knowledge and skills to develop solutions framed within the necessary economic terms and limits.

[16] Taken and adapted from Bethlehem and Goldblatt, p. 208.

Different attempts to engage SMEs in mandatory or voluntary regulatory schemes have had limited or null success (Friedman and Miles, 324). Therefore, a poor environmental performance is expected from SMEs. In addition, systematic under-reporting can lead to serious under-estimation of occupational risk and occupational diseases and result in improper allocation of resources for prevention (Morse et al., 369).

An increasingly important topic is the immediacy and relevance of health and safety compared with environmental regulation. Health and safety risks involving environmental hazards at the workplace acquire more and more importance everyday and, in some cases, involve greater economic consequences as indicated when comparing imposed penalties from health and safety offences versus environmental offences (Petts et al., 21). In that case, the regulatory framework must protect the employees against immediate potential serious impacts derived from environmental hazards, a situation that can be translated as the convergence of environmental and health regulations in the field of SMEs.

Conclusions

A diversity of sciences and fields of knowledge from the areas of environmental and health management may converge in the small business level. Although with different approaches, nine field of knowledge were reviewed, analyzed, and integrated into a model that can provide insight on the environmental and health interactions at the firm level.

From their interaction it is possible to quantify environmental risks at the workplace via toxicological, epidemiological, and exposure assessment studies. From their interaction also is possible to prepare and develop preventive measures that would ultimately reduce the risks to human health.

The convergence may provide additional elements and may be used for policy making purposes; as proposed in this thesis, more integration between environmental and health sciences can lead to a more robust method for the analysis and proposal of environmental and health policies. Prevention of disease should be a main concern in the environmental and health interaction.

Chapter 4: Environmental and Health Management in Small and Medium size Enterprises: the Mexican printing industry case study

In chapter 4, the model proposed in chapter 3 is exemplified for Mexican printing sector. As part of this chapter, a general review of the economic and social importance of the sector is presented along with environmental and health data. A review of the substances commonly used is included along with the regulatory framework applicable to the sector. Estimations concerning possible morbidity and mortality derived from work-related diseases are included. Finally, general recommendations are presented.

Economic relevance and business composition of the Mexican printing sector

The printing sector is codified as number 3420 under the North America Industrial Classification Systems (NAICS). The activities in this industrial sector include newspapers and periodicals publishing, book publishing, printing and binding, and printing supporting industries such as paper production, platemaking, and ink manufacture. Figure 12 shows the procurement chain for the Mexican printing industry. As economic activity, the printing and publishing sector is classified as title IV of the manufacturing industry.

By year 1997, the sector generated 4.4 % of national gross domestic product. According to the most recent industrial census (1998), more than 16,800 companies participate in the Mexican printing sector, 85.8 % of them as printing and binding companies (Table

12). 78% of the total number of companies is located in four Mexican states: Federal District, State of México, Nuevo León, and Jalisco (Dini, Corona, and Jaso, 16).

The printing sector employs more than 140,000 workers, most of them in printing and binding firms (62.2 %) and a significant share in newspaper and periodicals publishing companies (25.9 %). Both activities employ almost 90% of all the workers in the sector (Table 13). Occupations related to the printing industry are pre-press technicians and workers, printing machine operators, machine setters or operators, and bookbinders. Most of the workers in the printing industry are informally trained on the job while working as assistants or helpers of experienced operators (BLS, 2004[17])

The sector is comprised almost completely by SMEs; by 1998, 92.4 % of the companies were micro (less than 5 workers) and 7.2 % were small and medium sized. Only 0.4% of the businesses were large companies. Figure 9 graphically summarizes the economic relevance of SMEs in the printing sector.

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[17] Bureau of Labor Statistics. (2004). Occupational Outlook Handbook 2004-05 edition. USA. http://www.bls.gov/oco/

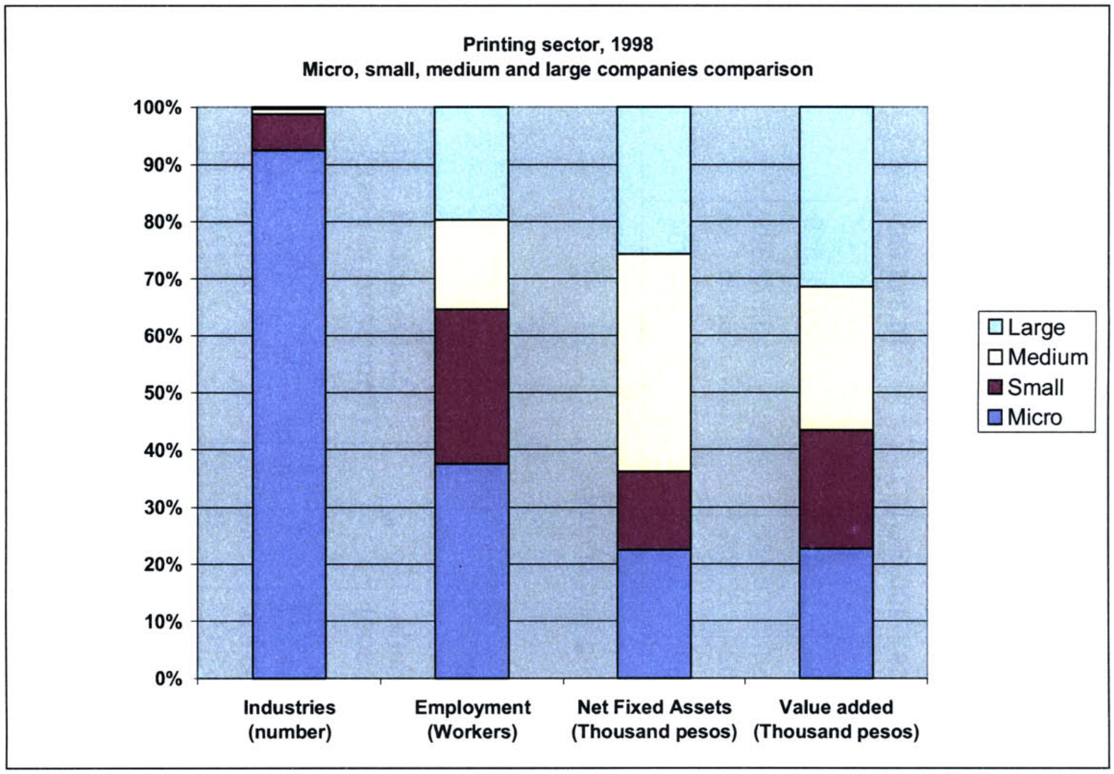

Figure 9: Economic relevance of SMEs in the printing sector in Mexico (1998).

Table 12: Printing and printing supporting industries by NAICS code, 1998

NAICS code		Industries (number)	%	Employment (Workers)	%	Value added (Thousand pesos)	%
3420	Publishing, Printing and Support Industries	**16,874**	**100.0%**	**142,759**	**100.0%**	**16,312,661**	**100.0%**
342001	Newspaper and periodicals publishing	1,248	7.4%	36,988	25.9%	5,828,519	35.7%
342002	Book publishing	470	2.8%	12,750	8.9%	3,372,669	20.7%
342003	Printing and binding	14,475	85.8%	88,752	62.2%	6,826,739	41.8%
342004	Printing supporting Industries	681	4.0%	4,269	3.0%	284,734	1.7%

Soruce: INEGI, XV Censo Industrial 1998.
Manufacturing Industries subsector 34. Paper production, paper products, publishing, and printing

Table 13: Publishing, printing, and printing supporting industries by size, 1998

Size	Industries (number)	%	Employment (Workers)	%	Net Fixed Assets (Thousand pesos)	%	Value added (Thousand pesos)	%
Micro	15,592	92.4%	53,568	37.5%	5,126,306	22.5%	3,711,984	22.8%
Small	1,068	6.3%	38,588	27.0%	3,139,727	13.8%	3,371,822	20.7%
Medium	150	0.9%	22,511	15.8%	8,695,614	38.1%	4,104,175	25.2%
Large	64	0.4%	28,092	19.7%	5,851,171	25.6%	5,124,680	31.4%
Total	**16,874**	**100.0%**	**142,759**	**100.0%**	**22,812,818**	**100.0%**	**16,312,661**	**100.0%**

Source: INEGI, XV Censo Industrial 1998.
Manufacturing Industries subsector 34.
Paper production, paper products, publishing and printing

Printing industry processes

The printing activities are divided in three main stages: pre-press, printing, and finishing. Pre-press relates to the preparation of materials for printing; in this stage of the printing process, the images of the material to be printed are produced photographically or electronically. Composition and typesetting are the first activities of pre-press, followed by their assembling into the material to be printed; the image is then transferred to the plate which is the carrier of the image to the paper. According to the printing method and technology used, the transfer produces a negative or a positive image over a copper cylinder, a metal plate, a plastic or rubber plate, or a porous polyester mesh. Developers, fixers, acid substances, and cleaning solutions are some of the chemical substances used in the pre-press stage.

After the pre-press is completed, the printing initiates. Six printing methods are used: digital, flexography, lithographic, gravure, letterpress, and screen printing. All the six printing methods operate under the same principle of printing an image over a substrate; variations come from the type of substrate used, the length and speed of the process, the obtained image quality, and the end product produced (EPA, 27). A cylinder or a plate is prepared as the carrier of the image; the cylinder is wetted with ink using an ink fountain and a fountain solution to repel the ink in areas where no image is to be printed; in other cases, the ink is picked up in the depressions of the cylinder. By contact between the carrier cylinder and the paper, the inked images are printed to the desired material (paper, paperboard, labels, textile garments, etc.). Once the image has been printed, mechanical or thermal processes accelerate the evaporation of solvents present in the ink in order to fix the image to the final printed product. A comprehensive description of each of the printing processes can be read from the Environmental Protection Agency Sector Notebook for Printing and Publishing[18].

After the printing stage comes the finishing. Finishing operations include cutting, folding, and binding among other activities. Typically, a liquid or melted glue is used for binding.

During the printing process a number of chemical products are used. Lithography uses light-sensitive chemicals, oil-based inks, fountain solutions with isopropyl alcohol, and VOC solvents. In addition, washing, cleaning, conditioning, and moisturizing solutions are applied over plate and blanket cylinders as part of the preparation steps or as part of maintenance procedures. In gravure printing, oil-based inks are used as well as cleaning solutions. Electroplating compounds may also be used if the electromechanical engraving of the plate is done in the same firm. Flexography uses acid baths, photopolymers, oil-based or water-based inks, and solvents for cleaning, conditioning, and moisturizing of plates and ink systems. Screen printing also uses organic solvents, adhesives, and oil-based or water-based inks.

[18] EPA. (1995). "Profile of the Printing and Publishing Industry". Sector Notebook Project. USA. EPA/310-R-95-014.

Environmental hazards in the printing industry

The printing industry is a major emitter of Volatile Organic Compounds (VOC) (EPA, 1995). Aromatics, aliphatic hydrocarbons, alcohols, halogenated hydrocarbons, ethers, ketones, and petroleum distillates solvents are daily used in the printing businesses. In the printing processes in general and in offset printing in particular, workers may be exposed to acute or chronic concentrations of organic solvents such as toluene, xylene, chlorinated hydrocarbons, n-butyl acetate, ethyl isobutyl ketone, or isopropyl alcohol, among many others.

Solvents are used for moisturizing rolls, cleaning plates, or may be incorporated as component of ink. Exposure levels vary among firms and will depend on the practices of each company; i.e. in a Norway study on exposure to organic solvents in offset printing, occupational physicians measured solvents concentrations that ranged from 0.8 ppm to over 100 ppm for isopropoyl alcohol, between 0.4 and 4.7 ppm for aliphatic hydrocarbons, from 0.0 to 2.7 ppm for toluene, and between null to 3.0 ppm for other solvents (Svendsen and Rognes, 122). In the case of isopropyl alcohol, neuro-psychiatric symptoms are present at concentrations between 50-100 ppm and an impairment neuro-psychological performance occurs in exposures to 100 ppm (Chouanière et al., 77).

Use of solvents in the printing industry has evolved towards substances with less harm, from aliphatic compounds, such as Stoddard solvent, xylene, toluene and chlorinated hydrocarbons to paraffins, cycloparaffins, terpenes or water-based solvents (Svendsen and Rognes, 119). However, workers in the printing industry are commonly exposed to carcinogenic solvents that may cause leukemia, small cell carcinoma of the lung, and other hematopoietic disorders. Exposure may also result in acute effects including depression of the central nervous system, headache, nausea, dizziness, vomiting, dermatitis, and irritation of eyes, nose, throat and skin (Xiao and Levin, 2000). It has been demonstrated that acute and chronic exposures to solvents mixtures result in neurobehavioral effects such as impaired performance on manual dexterity, visual memory and mood disturbances (White et al. 1995).

A combination and interaction of solvents may have additive effects in workers health. i.e. isopropyl alcohol, a common solvent used as rolls moisturizer, with effects in the central nervous system, may also reinforce the effects of other substances such as the effects of chlorinated solvents in the liver, or may later be metabolized to acetones that are eliminated through exhalation or urine (Svendsen and Rognes, 123).

In México, there is no aggregated information about the solvent emissions due to printing activities. Reported releases from the United Sates Toxics Release Inventory may give a hint of the emissions and releases volume due to the printing industry. As a reference, printing sector in the United States is comprised by nearly 70,000 facilities, 84% of which are classified as SMEs. As can be shown in Figure 10, more then 8,500 million tons of chemical compounds were released as emissions to the air in the United States in 2001. Occupational exposure to organic solvent in the printing industry may represent a major risk factor for a number of diseases.

Row #	Chemical	Total Air Emissions	Surface Water Discharges	Underground Injection	Releases to Land	Total On-Site Releases	Total Off-site releases	Total On-and Off-site releases
TRI On-site and Off-site Reported Releases in pounds for facilities in Printing (SIC 27) for All Chemicals U.S. 2001 (lbs)								
1	1,2,4-TRIMETHYLBENZENE	105,278.00	-	-	-	105,278.00	179	105,457.00
2	2-ETHOXYETHANOL	9,758.00	-	-	-	9,758.00	-	9,758.00
3	2-METHOXYETHANOL	500	-	-	-	500	-	500
4	AMMONIA	22,097.00	-	-	-	22,097.00	-	22,097.00
5	ANTIMONY	-	-	-	-	-	-	-
6	BARIUM COMPOUNDS	3,323.00	-	-	17	3,340.00	2,997.00	6,337.00
7	BENZO(G,H,I)PERYLENE	-	-	-	-	-	-	-
8	CERTAIN GLYCOL ETHERS	533,119.00	5	-	3,337.00	536,461.00	14,580.00	551,041.00
9	CHLORODIFLUOROMETHANE	-	-	-	-	-	-	-
10	CHROMIUM COMPOUNDS(EXCEPT CHROMITE ORE MINED IN THE TRANSVAAL REGION)	-	-	-	-	-	-	-
11	COBALT COMPOUNDS	-	-	-	-	-	-	-
12	COPPER	-	-	-	-	-	10,162.00	10,162.00
13	COPPER COMPOUNDS	2,257.00	24	-	5	2,286.00	18,342.00	20,628.00
14	CUMENE	-	-	-	-	-	-	-
15	DIBUTYL PHTHALATE	-	-	-	-	-	-	-
16	DICHLOROMETHANE	-	-	-	-	-	-	-
17	DIETHANOLAMINE	-	-	-	-	-	-	-
18	DIISOCYANATES	1,934.00	-	-	-	1,934.00	252	2,186.00
19	DIMETHYL PHTHALATE	42	-	-	-	42	-	42
20	ETHYL ACRYLATE	-	-	-	-	-	-	-
21	ETHYLBENZENE	18,975.00	-	-	-	18,975.00	15	18,990.00
22	ETHYLENE GLYCOL	102,603.00	-	-	-	102,603.00	-	102,603.00
23	FORMALDEHYDE	-	-	-	-	-	-	-
24	HYDROQUINONE	-	-	-	-	-	-	-
25	LEAD	52.63	-	-	-	52.63	191	243.63
26	LEAD COMPOUNDS	0.01	-	-	408	408.01	23,054.22	23,462.23
27	MERCURY COMPOUNDS	0.05	-	-	-	0.05	-	0.05
28	METHANOL	150,724.00	-	-	-	150,724.00	1,224.00	151,948.00
29	METHYL ETHYL KETONE	466,260.00	-	-	-	466,260.00	19,232.00	485,492.00
30	METHYL ISOBUTYL KETONE	93,174.00	-	-	-	93,174.00	12,316.00	105,490.00
31	MIXTURE	30,070.00	-	-	-	30,070.00	17,542.00	47,612.00
32	N-BUTYL ALCOHOL	1,906.00	-	-	-	1,906.00	-	1,906.00
33	N-HEXANE	8,391.00	-	-	-	8,391.00	-	8,391.00
34	N-METHYL-2-PYRROLIDONE	48,193.00	-	-	-	48,193.00	46,688.00	94,881.00
35	NAPHTHALENE	34,954.00	-	-	-	34,954.00	-	34,954.00
36	NICKEL	500	-	-	-	500	255	755
37	NICKEL COMPOUNDS	-	-	-	-	-	129	129
38	NITRATE COMPOUNDS	2,110.00	-	-	-	2,110.00	750	2,860.00
39	NITRIC ACID	5,368.00	-	-	-	5,368.00	527	5,895.00
40	OZONE	40,581.00	-	-	-	40,581.00	-	40,581.00
41	POLYCYCLIC AROMATIC COMPOUNDS	915	-	-	-	915	-	915
42	SULFURIC ACID (1994 AND AFTER 'ACID AEROSOLS' ONLY)	10	-	-	-	10	-	10
43	TETRACHLOROETHYLENE	16,939.00	-	-	-	16,939.00	-	16,939.00
44	TOLUENE	17,137,222.00	29	-	-	17,137,251.00	154,409.00	17,291,660.00
45	TRICHLOROETHYLENE	25,452.00	-	-	-	25,452.00	-	25,452.00
46	VINYL ACETATE	64	-	-	-	64	-	64
47	XYLENE (MIXED ISOMERS)	321,772.00	209	-	-	321,981.00	680	322,661.00
48	ZINC COMPOUNDS	101,466.00	38	-	764	102,268.00	93,425.00	195,693.00
	Total (lbs)	19,286,009.68	305	-	4,531.00	19,290,845.68	416,949.22	19,707,794.90
	Total (kg)	8,766,368.04	138.64	-	2,059.55	8,768,566.22	189,522.37	8,958,088.59

Figure 10: Release from printing facilities in the U.S.A.

A selected number of studies with estimates in risk increase from occupational exposures are shown in Table 14.

Table 14: Disease and relative risksdue to occupational exposure

Disease	Breast cancer	non-Hodgkin's lymphoma	Fatty liver disease	Colon cancer	Neurobehavioral disturbances	Ovarian cancer	Malignant gliomas
Agent	organic solvent	trichloroethylene	organic solvents	Mineral oils	Toluene	solvents, ionizing radiation, asbestos, pesticides, and diesel	
OD / RR	1.51		4.3	2.5*	1.31	1.03	0.6
IR		1.2 (1.4*)					
C.I. (95%)	1.10 - 2.04	1.0 - 1.5	1.2 - 15.0	0.9 - 6.7	0.97 - 1.75	0.8 - 1.4	0.2 - 2.3
Industry	Food and drink, textile, furniture, **printing**, chemical, basic metal, fabricated metal, nonmetallic mineral products, sanitary and similar services, social and related services, service and repair	Iron and metal, electronics, painting, **printing**, chemical, dry cleaning		Textile oils, heat treating oils, rolling oils, drawing oils, rubber oils, forging oils, mold-release oils, **ink formulation**.	**Printing**		55 occupational groups including **printers**
Study	matched case-control	cohort	case-control	case-control	cross-sectional	follow-up	case-control
Population studied	Denmark	Denmark	Östergötland, Sweden	Montreal, Canada	France	Sweden	San Francisco, USA
Author	Hansen, J. 1999	Raaschou-Nielsen. 2003	Lundqvist,Flodin, Axelson. 1999	Goldberg et al. 2001	Chouanière et al. 2002	Shields et al. 2002	Carozza et al. 2000
Notes		* firms <50 employees		* when +5 years of exposure		OD for printing industry, different values appear per occupation within the sector	data for less than 10 years latency period

Form epidemiologic studies is possible to determine morbidity and mortality rates, as frequent measures of the population's health, or moreover, of the employees' health. However, in México no information is maintained about incidence rates from occupational exposures and it is difficult to estimate them because lack of information about the population at risk. The Mexican Information System of Epidemiologic Surveillance (SUIVE[19]), as possible source of information, does not report occupational diseases.

In either case, some proxies can be obtained using incidence rates for the main causes for mortality. As highlighted in Table 15, four out of the twenty main causes of mortality for population in reproductive age are diseases with possible causality derived from occupational exposures and work health related problems. The rates reported are per 100,000 inhabitants.

As can be seen from Table 15, nearly 7% of total number of deaths for population in reproductive age in México is due to 4 different diseases. If ischemic heart disease is added, the proportion increases from 7% to 14%. As classified under the ICD-10, these diseases may have a possible occupational causality. It is clear that the possible existence of this causality by no means suggests that the mortality numbers for the Mexican population are due to occupational exposures[20]; however, a small fraction of the total diseases number may be due to workplace conditions or job-related exposures.

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[19] SUIVE: Sistema Único de Información de Vigilancia Epidemiológica.
[20] The purpose of this comparison is to highlight the main causes of mortality and to mention that, in a small fraction, they have a possible connection with occupational exposures.

Table 15: Mortality and disease cause in population in reproductive age

Main mortality causes for population in reproductive age (15 to 64 years old), 2001.
National

Rank	ICD-10 Code	Disease	Deaths	Rate 1/	%
	A00-Y98	Total	165,833	260.58	100.0
1	E10-E14	Diabetes mellitus	20,064	31.53	12.1
2	K70, K72.1, K73, K74, K76	Cirrosis y otras enfermedades crónicas del hígado	17,387	27.32	10.5
3	I20-I25	Enfermedades isquémicas del corazón	11,846	18.61	7.1
4	2/	Accidentes de tráfico de vehículo de motor	10,303	16.19	6.2
5	X85-Y09, Y87.1	Agresiones (homicidios)	8,865	13.93	5.4
6	I60-I69	Enfermedad cerebrovascular	6,104	9.59	3.7
7	B20-B24	VIH/SIDA	4,136	6.50	2.5
8	N00-N19	Nefritis y nefrosis	3,992	6.27	2.4
9	X60-X84, Y87.0	Lesiones autoinfligidas intencionalmente (suicidios)	3,290	5.17	2.0
10	F10, G31.2	Uso de alcohol	3,255	5.11	2.0
11	C53	Tumor maligno del cuello del útero	2,838	4.46	1.7
12	C50	Tumor maligno de la mama	2,509	3.94	1.5
13	I10-I15	Enfermedades hipertensivas	2,333	3.67	1.4
14	J10-J18, J20-J22	Infecciones respiratorias agudas bajas	2,212	3.48	1.3
15	C33-C34	Tumor maligno de tráquea, bronquios y pulmón	2,161	3.40	1.3
16	C16	Tumor maligno del estómago	2,023	3.18	1.2
17	A15-A19, B90	Tuberculosis	2,010	3.16	1.2
18	J40-J44, J67	Enfermedad pulmonar obstructiva crónica	1,957	3.08	1.2
19	C91-C95	Leucemia	1,630	2.56	1.0
20	W65-W74	Ahogamiento y sumersión accidentales	1,491	2.34	0.9
	R00-R99	Causas mal definidas	1,672	2.63	1.0
		Las demás	53,755	84.47	32.4

1/ Rate per 100,000 inhabitants
2/ V02-V04 (.1, .9), V09.2-V09.3, V09.9, V12-V14 (.3-.9), V19.4-V19.6, V20-V28 (.3-.9), V29-V79 (.4-.9), V80.3-
Source: Prepared by CONAPO with mortality data from INEGI/Secretaría de Salud.Dirección General de Información en S
CONAPO, 2002. "Proyecciones de la Población de México, 2000 - 2050".

The incidence rate per age group is further detailed in Table 16. In this table, all the diseases from the Mexican Catalog of Diseases that may have an occupational component are included. For only three of the most than twenty diseases included report an incidence rate.

Table 16: Number of patients per disease and per age group, 2002.

Disease	ICD-10	Total	Age groups								NE	Incidence rate*
			< 7 days	7 a 28 days	29 days to 11 months	1 a 4 years	5 a 14 years	15 a 44 years	45 a 59 years	60 y más years		
Total	**A00-Z99**	**1,635,301**	**72,814**	**11,579**	**49,282**	**67,181**	**99,422**	**1,053,323**	**127,697**	**153,984**	**19**	
Transmissible diseases		**12,158**	**78**	**90**	**1,881**	**3,404**	**1,911**	**2,577**	**854**	**1,363**	**0**	
Infecciones respiratorias agudas altas	J00-J06	7,008	66	87	1,506	2,979	1,370	698	130	172	0	28,874.3
Anemia	D50-D64	5,150	12	3	375	425	541	1,879	724	1,191	0	
Non-transmissible diseases		**148,373**	**669**	**335**	**3,919**	**10,484**	**15,450**	**52,014**	**26,917**	**38,584**	**1**	
Tumor maligno del hígado	C22	723	0	0	9	104	49	79	156	326	0	
Tumor maligno de tráquea, bronquios y pulmón	C33-C34	1,148	0	0	0	3	8	134	280	723	0	1.5
Melanoma y otros tumores malignos de la piel	C43-C44	1,084	1	0	3	13	19	234	217	597	0	
Tumor maligno de la vejiga	C67	419	0	0	0	12	4	31	108	264	0	
Leucemia	C91-C95	5,561	6	6	73	1,165	2,169	1,596	274	272	0	
Otros tumores malignos	C17,C23,C24,C26-C32,C37-C41,C45-C49,C51,C52,C57-C60,C62-C66,C68-C80, C96, C97	9,500	4	7	101	618	1,180	3,458	1,724	2,408	0	
Otros trastornos neuropsiquiátricos	F04-F09,F17,F34-F39,F401-F409,F411-F419,F44-F50, F52-F69, F80-F99,G10-G12,G23-G25,G36,G37,G44-G90, G92-	10,472	98	38	147	507	1,055	5,564	1,547	1,516	0	
Cataratas	H25-H26	6,462	0	0	2	29	176	574	1,083	4,598	0	
Enfermedad pulmonar obstructiva crónica	J40-J44, J67	7,178	2	3	53	63	37	487	894	5,639	0	
Asma	J45-J46	8,265	28	13	459	2,759	2,016	1,634	638	718	0	274.6
Otras enfermedades respiratorias	J30-J39,J47-J66, J68-J99	18,966	263	78	1,151	2,433	3,637	6,277	1,838	3,289	0	
Otras enfermedades digestivas	K20-K22, K28-K31, K38, K42-K66, K71-K72.0, K72.9, K75, K82-K92	48,464	255	167	1,789	2,279	2,497	18,749	11,273	11,454	1	
Nefritis y nefrosis	N00-N19	30,131	12	23	132	499	2,603	13,197	6,885	6,780	0	
Injuries		**10,978**	**89**	**37**	**293**	**2,056**	**2,152**	**4,607**	**894**	**850**	**0**	
Envenenamiento por drogas y sustancias biológicas y efectos tóxicos de sustancias no medicinales	T36-T50, T51-T65	8,944	22	26	188	1,387	1,693	4,134	775	719	0	
Los demás traumatismos, envenenamientos y otras consecuencias de causas externas	T15-T19, T33-T35, T66-T78,	2,034	67	11	105	669	459	473	119	131	0	
Otras causas de contacto con los servicios de salud		**16,607**	**2,317**	**41**	**302**	**857**	**1,786**	**7,055**	**2,342**	**1,907**	**0**	
Los demas factores que influyen en el estado de salud y contacto con los servicios de salud	Z00.0, Z00.2-Z00.8, Z01-Z10, Z20-Z29, Z31-Z33, Z37-Z99	16,607	2,317	41	302	857	1,786	7,055	2,342	1,907	0	
Causas mal definidas	**R00-R99**	**14,722**	**239**	**62**	**908**	**1,716**	**2,463**	**5,277**	**1,679**	**2,378**	**0**	

Fuente: Secretaría de Salud. Dirección General de Información en Salud. SAEH

If the published incidence rates for asthma, malignant neoplasms of bronchus and lung, and respiratory disease are combined with the number of employees in the printing industry, a rough estimate about the possible number of individuals that may develop the disease may be obtained (Table 17). The estimation was made dividing the number of employees by the incidence rate for the specific disease (measured per 100,000 inhabitants). The result gives the possible number of diseases that would exist if all the workers were considered as population at risk.

Table 17: Non-fatal non-transmissible diseases, 2002

			Incidente rate per 100,000 inhabitants		
			28,874.3	1.5	274.6
			Number of diseases		
Size	Industries (number)	Employment (Workers)	Respiratory disease	Malignant neoplasm bronchus and lung	Asthma
Micro	15,592	53,568	15,467.39	0.80	147.10
Small	1,068	38,588	11,142.01	0.58	105.96
Medium	150	22,511	6,499.89	0.34	61.82
Large	64	28,092	8,111.37	0.42	77.14
Total	**16,874**	**142,759**	**41,221**	**2**	**392**

Without relevant incidence rates from occupational diseases is really difficult to estimate accurate rates and absolute numbers per disease. Therefore, it is practically impossible to determine the gravity of the occupational exposure in the health of the working population, even when some of the main mortality causes may have an associated workplace component.

Regulatory framework for the sector

Environmental and health management is regulated by three different Federal Ministries: the Ministry of Environment (SEMARNAT), the Ministry of Health (SSA) and the Ministry of Labor (STPS). Specific departments within each Ministry formulate policy or enforce regulation on environmental and health related topics.

Within the SEMARNAT, the National Institute of Ecology (INE) and the Federal Bureau for Environmental Protection (PROFEPA) are responsible for the development of environmental policies and their enforcement respectively.

Within the SSA, the General Direction of Preventive Medicine, the General Direction of Epidemiology, and the General Direction of Environmental Health are responsible for the development of national policies, the assessment of environmental hazards and the enforcement of health regulations. Their main focus is on public health and on industries whose products may generate a health risk (beverages, food, cleaning products, tobacco, and cosmetic industries).

Within the STPS, the General Direction of Safety and Hygiene in the Workplace is responsible for the development of health and safety regulations, the promotion of workplace health and safety commissions, and the research activities on occupational risks.

As shown in Table 18, the topics covered by Mexican regulations are limited and emphasize occupational risks as a general concern, without establishing any interaction, joint effort, or complementarily actions. Each regulation is independently enforced by each Ministry via their human and financial resources.

Environmental regulations address air emissions from point sources of twelve specific industrial sectors without distinguishing between company sizes. Information is collected via an annual certificate of operation (Cédula de Operación Anual), which is a self-regulatory mechanism that has to be filled by each facility once a year. Printing and publishing is not part of the list.

Labor regulations are applicable to every company in México although exemptions are made to small businesses, defined as those businesses whose members have a blood kinship.

The main approach followed by Mexican regulations is from Industrial Hygiene, Industrial Safety, and Environmental Management. To a lesser extent an approach from Occupational Health and Risk Assessment has been tried with very limited applications and practical results. The Health Law is limited in its reach and although establishes a mandate for the Health Ministry on the establishment of maximum exposure limits, it has not been accomplished. Less than 5 official norms on exposure limits have been developed in the last 10 years.

Table 18: Selected Mexican regulations in Environmental and Health management.

Law or regulation	Topics covered	Comments
Social Security Law	Occupational risks (illnesses and diseases)	Follows an Industrial Hygiene approach
Labor Law	Occupational risks Definition of occupational illness and disease	N/A for family businesses defined as business where members have blood kinship
Health Law	Occupational health	Health Ministry shall determine maximum exposure limits for the workplace and shall coordinate related toxicological studies.
LGEEPA	Hazardous waste management, wastewater discharges, air emissions to atmosphere, environmental impact, and product or industry specific environmental concerns	Regulates environment outside the workplace. For specific products, establishes limit values for substances content in final product, or specifies handling procedures for hazardous substances. Regulation for point sources from following industries: chemical, petroleum, petrochemical, paint and ink, automobile, cellulose and paper, iron and steel, glass, electricity generation, asbestos, cement, and hazardous waste management.
Federal Regulation on Health, Safety and Environment	Occupational risks	Follows an Industrial Hygiene approach and an Industrial Safety approach on specific issues. Requires a specific written program for 100+ employees firms. Otherwise, requires a list of preventive health and safety measures at the workplace. Fines between 15 to 315 times minimum wage[21] from non-compliance
NOM-005-STPS-1999	Health and safety conditions for hazardous substances handling and management	Requires design and update of a specific written program within the firm, including description of toxicological properties of substances.
NOM-010-STPS-1999	Health and safety conditions for production, transportation and handling sites of chemical substances with potential as environmental pollutant.	Includes a toxicity criterion [Lethal dose (LD_{50})], an exposure criterion [maximum exposure limits], a qualitative risk classification, and procedures for presence determination at workplace for 70 substances.
NOM-047-SSA1-1993	Biological exposure values and threshold limit values for organic solvents	Equivalent to the "Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposures Indices American Conference of Governmental Industrial Hygienists" (ACGIH).
NOM-048-SSA1-1993	Risk assessment standard methodology	Loose definition of risk and corrective approach to risk assessment. Norm includes a series of numbered steps without specifying measuring units, links with existent norms, or relation with support sciences such as Epidemiology, Toxicology, or Risk Assessment.

[21] The minimum wage is adjusted every year by the National Commission for Minimum Wages. The Mexican territory is divided in three regions (A, B, and C) and each region has a corresponding minimum wage. Region A has the highest minimum wage. For 2004, the minimum wage for Region A is $45.24 pesos per day, equivalent to USD$ 4.20 per day (@ exchange rate of $10.8 pesos per dollar)

Using the tri-circle model for environmental and health management, as proposed in chapter 3, a deeper understanding of the approach followed by the Mexican regulation may be obtained (Figure 11).

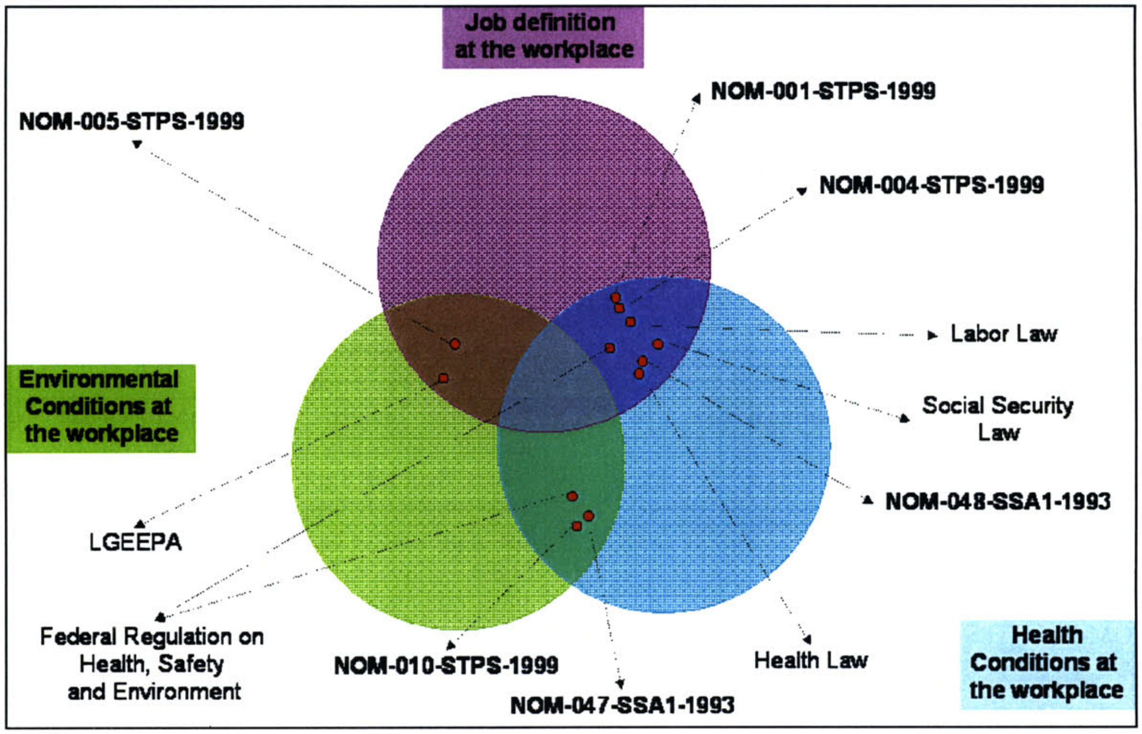


Figure 11: Mexican regulatory framework at the firm level

It can be argued that the regulatory framework in México does not really address the situation of SMEs and does not establish specific provisions per industrial sector. Overall, there is no comprehensive emissions inventory that could be used to monitor occupational diseases nor exists a occupational diseases database that could track the environmental conditions in the workplace per industrial sector or per company size.

An Environmental and Health Management model for Mexico

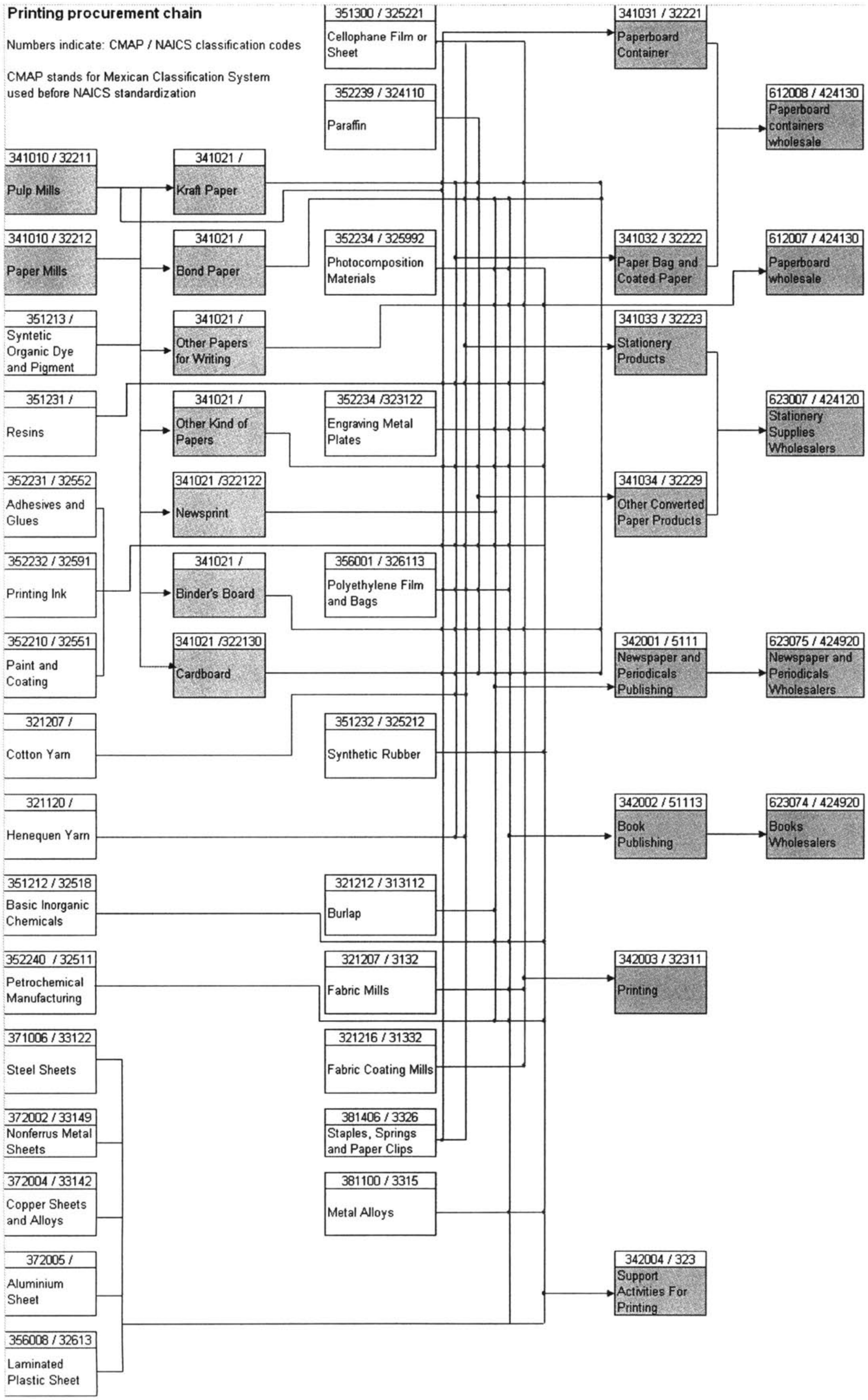
A major breakthrough in the environmental and health management practices in México could be generated by a closer coordination among Labor, Health, and Environment Ministries. In the case of Mexico, specific tactical recommendations can be made to link environmental and health management:

1. **Occupational census**: to obtain employment and exposure history of representative samples of working population. Information to be gathered: job chronology including job title, type of industry, work start and termination year if unemployed, working hours, a checklist of major types of exposure, and frequency of use of protective equipment. This occupational census can be prepared by a joint committee from the Ministry of Health and the Ministry of Labor; the field work can be done by INEGI through a specific project or by incorporating a set of additional questions in the Population Census or in the Industrial and Economic Census.
2. **Workplace exposure measurement**: A program on workplace exposure can be developed and executed jointly by a team from the Ministry of Health and the Ministry of Environment. Exposure measurements may be done through biologic markers assays, immunotoxic effects assays, or even genetic susceptibility if required, As a result of the assessment, a number of activities may accrue: a revision of current exposure limits, the development of sector specific exposure limits, the generation of sector specific fact sheets for chemical substances, or even the prescription of work restrictions or of medical treatments for exposed population if necessary.

3. **Environmental Risks and Occupational Diseases Monographs Series**: Prepare monographs for specific environmental risk and occupational diseases per industrial sector or chemical compound. Each monograph may include the following information: (1) toxicity, (2) exposure pathway, (3) metabolic ways and biologic fate, (4) physiological effects from acute and chronic exposure, (5) clinical evaluation, (6) treatment, and (7) applicable regulation at the workplace. The Series may be jointly prepared by the three federal agencies.
4. **Exposure limits**: The new research center on Environmental Health within the National Institute of Public Health, in collaboration with the General Direction of Epidemiology from the Health Secretariat[22] may foster occupational exposure limits or standards, develop epidemiologic research, disseminate information, and design targeted programs on occupational health, environmental risk reduction, and risk assessment. These tasks may be jointly with the National Institute of Ecology from the Environment and Natural Resources Secretariat[23].
5. **Occupational diseases database**: A national database may be set up to concentrate information generated from exposure assessments, occupational census, and the monograph series. Information collected may be used in the future for epidemiologic studies, risk assessment, and environmental management practices.

[22] Secretaría de Salud
[23] Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT).

Figure 12: Printing procurement chain in Mexico.



Conclusions

The regulatory framework in México does not really address the situation of SMEs and does not establish specific provisions per industrial sector. A deeper understanding of the industrial sectors that dominate the economy of Mexico may provide a useful insight of the existent environmental hazards and the existent environmental management practices.

Small and Medium size Enterprises, as main social and economic players, may be willing to improve their environmental performance and increase their overall care for their employees' health. The willingness may come from social pressure towards the right thing to do and can be reinforced by a regulatory framework that emphasizes the health effects of environmental hazards.

A reduction in risk derived form environmental hazards may be obtained by a closer collaboration between regulatory agencies. Although neither have a specific area that addresses the topic of environmental and health management, a joint participation in projects with mutual benefits may improve the availability of information and the generation or review of the regulatory framework.

An increased use of ICD-10 in the classification of diseases may also provide a standard method to classify and compare diseases, and furthermore, to determine the their relationship with working conditions in the small firms, the health conditions of the working force, and the environmental conditions that prevail in small businesses.

The present work provides enough information to let the federal or state agencies develop specific programs that may improve the environmental performance of small business and the health conditions of the population.

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American Board for Occupational Health Nurses: http://www.abohn.org/
American Board of Preventive Medicine: http://www.abprevmed.org/
American College of Occupational and Environmental Medicine. http://www.acoem.org/
American Conference of Governmental Industrial Hygienists http://www.acgih.org/home.htm
American Industrial Hygiene Association: http://www.aiha.org/
American Society of Safety Engineers: http://www.asse.org/
Board of Certified Safety Professionals http://www.bcsp.com/safpro_fr.html
Center for Disease Control and Protection http://www.cdc.gov/niosh/hc24.html
Encyclopaedia of Occupational Health and Safety http://www.ilocis.org/en/aboutilo1.html
Institute of Occupational Medicine. http://www.iom-world.org/
International Commission on Occupational Health http://www.icoh.org.sg/index.html
Integrated Risk Information System http://www.epa.gov/iris/index.html
International Occupational Hygiene Association http://www.ioha.net
International Union of Toxicology http://www.toxicology.org/iutox/
National Center for Environmental Health http://www.cdc.gov/nceh/ehs/home/Obj.htm
Sistema de Información Empresarial Mexicano http://www.siem.gob.mx/portalsiem/
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