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The Impact of Regulation on Occupational Safety – A Regional Study for Italian Food Industry

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This paper analyses the impact of the most recent Italian safety national regulation (Dlgs. 81/08) on the occupational accidents frequency and severity in Food and Drink Industry.
Food and Drink Industry (FDI) is a branch of manufacturing sector with a relevant role in European Union and Italian economy. Far away from the common way of thinking, the FDI sector has an accident frequency comparable to those of other manufacturing sectors. The occupational accidents analysed were more than 6000, all occurred in Piemonte, a north west region of Italy, from 2006 to 2013. The study was carried out analysing the relationships between occupational accidents trend and macro-economic variables concerning the degree of employment, the worked hours and working force distribution. Furthermore a specific focus was done on evolution of the occupational accidents dynamic with the using of an innovative clustering method named SKM (S.O.M & K-Mean method). This study identified as relevant factor in the occupational accidents reduction the effects of economical crisis expressed in term of smaller number of worked hours.
Results showed that big companies reported a bigger reduction of occupational accidents than small and micro enterprises.

1. Introduction

Food and Drink Industry plays an important role on EU-28's economy as reported by Eurostat (2014).
This sector generated in 2013 a turnover of E1090 billions with a value added of 212 billion and the 1,8% of the whole gross value added of EU economy.
FDI employees more than 4,25 millions of workers divided in 289000 companies with a relevant degree of diversification. Small and Medium Enterprises (SMEs) are the 99% of the enterprises involving the 62% of the employees and almost the 48% of the Value added of the sector.
Eurostat (2015) underlines that FDI was among the top three manufacturing industries in term of turnover and employees in most member states with particular emphasis for country as Germany, Italy, France, Spain and Poland. This crucial sector for EU economy has to deal with the occupational accidents phenomenon that still represent a serious problems for the whole world economies (Battaglia et al., 2014).
Several studies highlight that workers employed in FDI sector are exposed to several risks (Stave et. Al., 2007) and the resulting frequency of occupational accidents is high (Forsblom et al., 2005) and not far from other manufacturing branches as clearly reported for the UK market (HSE, 2013) and in Willquist (2005). Organisational level seems to have a strong relation with accidents frequency in FDI sector (Jacinto et al., 2009, Shirani et al, 2014). The economic and social consequences of occupational accidents have been deal by EU since 1989, when the protection of the health of workers was promoted by the Directive 89/391/EEC (1989).EU promoted the constant monitoring of the problem since 1990, when the European Statistics on Accidents at Work (ESAW) project was launched. A general trend of occupational accidents reduction was observed in EU during the period 1990-2009 (Eurostat, 2010).
This trend cannot be claimed totally to the effectiveness of EU policy and National Safety Regulation because several factors have an influence on it (Lehtola M., 2009): Fabiano (2004) related the occupational accidents

frequency to the technological factor and the enterprise size, Vredenburgh (2002) highlighted the role of work organization. The impact of the macro-economic factor was analysed by Kossoris (1998) and Morse (2009) who compared the decline of occupational injuries rates in the industries of USA to demographic changes in the workforce and to changes in industrial composition of economy.
Loomis (2004) suggested that deindustrialization process, with the shifting of more hazardous work to countries with less stringent laws requirements and working related costs contributed to the decline of occupational accidents. Furthermore a relationship between the decline of accident rates in EU and the current economic crisis that is ongoing in Europe since 2005 was analysed in Spain (de la Fuente V., 2014) and UK (Davies R., 2009). In Italy the INAIL (Italian institution for insurance against accidents at work) promotes safety campaigns and collects the occupational accident reports according with ESAW standards.
Italian occupational accident scenario of the last 25 years is characterised by a constant reduction of both fatal and non-fatal events as reported in Comberti (2017).
This work was focused on the analysis of occupational accidents trend in Food and Drink industry in Italy.
FDI is a crucial sector for Italian economy, it is the third sector in manufacturing for employment with 385000 workers officially involved and generates (Eurostat, 2013) a turnover of 132 billion of euro involving more than 54000 companies. This research was focused in Piemonte area, a north west region of Italy, that is traditionally characterized for important food and drink companies. This paper analyzed the impact of the most recent Italian safety national regulation (Dlgs. 81/08) on the occupational accidents frequency and severity in Food and Drink Industry.
In addition the occupational accidents data collected by INAIL in the last 10 years were analysed and compared to macro-economic index to evaluate the influence of socio economic changes.
Furthermore a specific focus was done on evolution of the occupational accidents dynamic with the using of an innovative clustering method named SKM (S.O.M & K-Mean method).
SKM method represents an efficient tool to deal with the occupational accidents data, thanks to its capability of grouping and visualizing data in a readable and exportable outcome. This method is able to identify families of accident with similar attributes from large and complex databases (Comberti et al., 2015).
This method was successfully applied in occupational accident s analysis of other manufacturing branches as mechanical (Murè et al.,2017) and Wood processing (Comberti et al., 2018).
In section 2 a short description of SKM is provided while Section 3 presents the results of the application over a case study. Conclusions and prospects for future work end the paper.

2. Methods

As mentioned in Introduction, this work analyses the influence of safety national regulation on occupational accidents frequency trend in FDI sector.
The methodology used in this study consist of two main stages:

- Stage1. Macro-economic analysis and comparison of occupational accidents trend with economic and social index.
- Stage 2. Occupational accidents dynamic analysis with SKM method.

Results obtained from Stage 1 and 2 allows a better understanding of occupational accidents evolution in the research field. The INAIL data base provides information on the number and the description of occupational accidents according with ESAW taxonomy occurred in Italy.
INAIL collects all the occupational accidents reported on the basis of a territorial Department structure, each Department elaborates yearly a general statistical report on data evolution.
In order to analyse the accidents related to FDI sector a set of rough data about occupational accident were obtained from the Regional INAIL bureau of Piemonte for the period 2006-2013.

2.1 Stage 1. Macro-economic analysis

As mentioned in Introduction of this work, social and macro-economic factors have an influence on occupational accident trend.
In order to assess this influence, a set of economic index were selected from the Italian Statistical Institution (ISTAT) reporting system and compared to the frequency of occupational accidents.
In particular information about number of workers employed, and workforce distribution were selected in order to taking into account the level of productivity of the sector.

2.2 Stage 2: SKM analysis

The purpose of this stage was to analyze the occupational accidents domain in FDI sector with the study of accidents dynamic evolution. The use of SKM (Comberti et al. 2018) allows to identify the families of accidents characterized by similar accidental dynamic. Analyzing the occupational accidents domain before (2006-2009)

and after (2010-2013) the emission of DLgs 81/08 will help in better understanding his influence on safety in FDI sector. SKM method is based in a two level of numerical analysis. The first level of data elaboration is applied to the coded data obtained from occupational accident DB. Through SOM (Self Organising Map) (Kohonen et al., 2000) , it is possible to produce a visual map of the data (Figure 1) following a projection process that is based on the similarity of the data. The map obtained is a non-metric map made of elementary units, characterized by different colors. As in Figure 1a, the color scale of the map reflects the perturbation on the units given by the density of projected data, the blue (darker) areas represent units with a large number of data projected, while red and yellow (lighter) areas represent empty units. The number of the blue areas can already reveal the number of groups of similar accidents, but in order to obtain an automatic clustering of the data it is necessary to apply the second stage of the method. The K-Means algorithm is applied to the numerical output deriving from the first phase, in order to produce a quantitative partition of the domain, on the basis of data similarity. The second phase provides the final data partition.

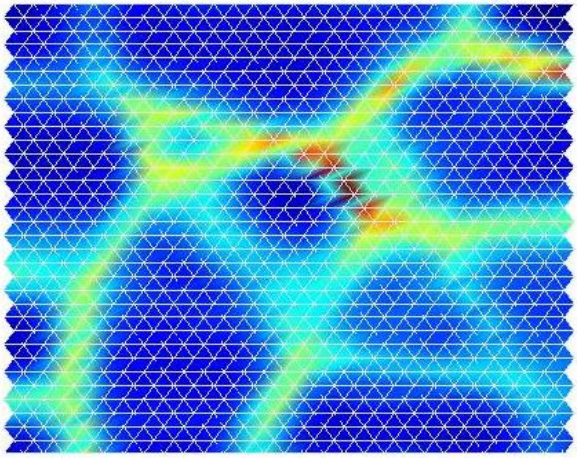


Figure 1: SOM map of Occupational accidents data set post 81/08

These clusters identify different families of accident dynamics that can be also related to the consequences of each accident (fatal or non-fatal injury, number of day of prognosis), to the characteristics of the person involved (age, experience, gender) and the company (dimension, sector…).This additional information represents a useful knowledge that can be used to classify the clusters on the basis of seriousness of the consequences. Using this classification system it is possible to identify which clusters are related to a major or minor seriousness and to a major or minor frequency of occurrence

3. Experiments

All the occupational accidents reported are considered officially recognized by the INAIL and from the insurance point of view treated. Since 2006 to 2013 more than 6000 non-fatal accidents were reported to Piemonte INAIL Offices. Figure 2a shows the number of nonfatal occupational accidents occurred in Piemonte since 2006 to 2013. A general trend, characterized by a decrease of the number of events, is easily observable. The total downgrade of occupational accidents reported to INAIL from 2006 to 2013 was of 50% of the value of 2006.The seriousness of accidents was calculated with the information related to the prognosis. Figure 2b presents the average prognosis for each year of observation. In this case a trend is not identifiable but the values have a short range of variation from a minimum of 29 days/event (2012) to a maximum of 34 days/event (2008). Occupational accidents were classified depending on the size of the enterprise were they occurred. The classification criteria was defined according with the Eurostat's Structural Business Statistics data-base: micro = less than 10; small = 10 to 49; medium = 50 to 249 and large = more than 250.
Figure 3 shows the evolution of the distribution of occupational accidents divided by enterprises size.

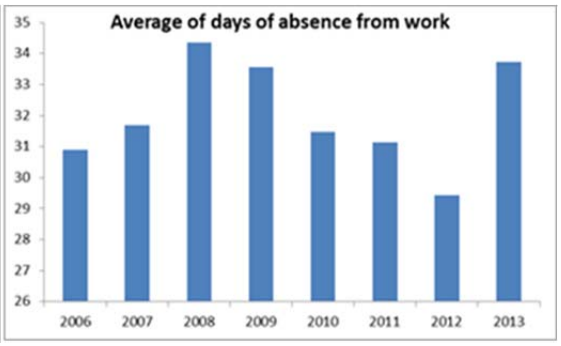


Figure 2a. Non Fatal Accidents in FDI in Piemonte reported to INAIL 2006-2013, Figure 2b. Average of days of absence from work in FDI in Piemonte reported to INAIL 2006-2013.

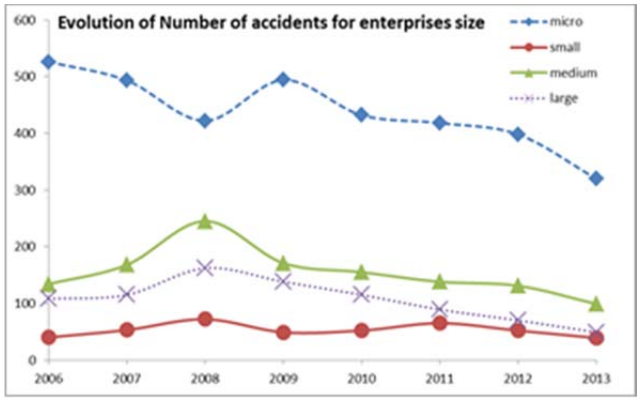
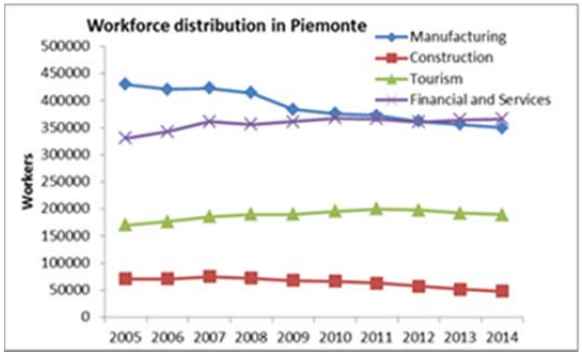


Figure 3. Evolution of the Accidents distribution for enterprise size.

3.1 Macro-economic data

Relevant changes in working force distribution were observed in the last 20 years (Figure 4a).
The "Financial and Services" and the "Tourism" sectors marked a constant upgrading to the detriment of all others. Manufacturing sector marked a negative trend in term of number of person engaged since 2005.
At the end of 2015 the loss of workers employed for the whole manufacturing sector was the 19% of 2005 value. This change in work-force distribution represents an indicator of the deindustrialisation process. Figure 4b shows the detail of manufacturing sector. The five major branches of manufacturing, in term of workers employed, are reported. It's evident that this period was characterized by a general contraction of employees in the whole manufacturing system. Mechanical branch, the largest sector, loses the 19% of the workers, Automotive signed a loss of 13% and Textile marked the strongest relative downgrade of 36%. At the same time the FDI sector slightly upgraded the number of employed worker of 6% becoming the third branch in manufacturing sector for number of regular employees.



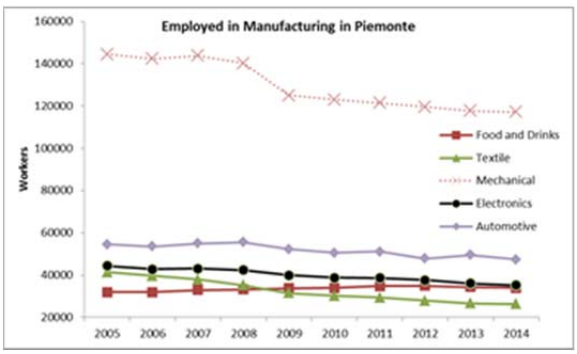


Figure 4a. Piemonte workforce distribution from 2005 to 2016; Figure 4b: Piemonte manufacturing work employees

3.2 SKM Results

INAL data set was divided in two sub-sets to analyze the evolution of the groups of accidents with similar dynamic after the emission of Dlgs. 81/08.
The method allowed the identification of 12 families of similar accidents that are resumed in Table 1 and 2.

Table 1: Occupational accidents families for 2006-2009 period.

Clusters	Events	Average Prognosis	Cluster Description
CL1	120	39	Working with hand tools, Movements and compression
Cl2	180	28	Manual transport, Movements with Efforts and Stress
Cl3	512	39	Driving, Control loosing and Crush.
CL4	324	29	Free movement and Falling down to a surface
CL5	95	26	Driving and lack of information
CL6	306	29	Working with hand tools, Control losings and body cutting
CL7	584	33	Uncomplete information
CL8	233	29	Objects handling, object breaking and impact
CL9	124	20	Objects handling, object breaking and cutting
Cl10	582	37	Free movement and Falling down, Compression
Cl11	547	31	Working machinery, Breaking or Contact, Various injuries
CL12	36	33	Objects handling, movements and cutting

Table 2: Occupational accidents families for 2010-2013 period.

Clusters	Events	Average Prognosis	Cluster Description
CL1	297	26	Free Movements and falling down to surface
Cl2	451	24	Objects handling, object breaking and cutting
Cl3	134	37	Uncomplete information
CL4	47	15	Object handling, Release and contact with fragment
CL5	239	37	Free movement and Falling down, Compressionheavy injuries
CL6	164	34	Objects handling, object breaking and heavy cutting
CL7	82	19	Objects handling, control losing and impact
CL8	353	35	Driving, Control loosing and Crush.
CL9	76	30	Free movement and Falling down, Compression
CL10	190	28	Working with hand tools , Control losings and body cutting
Cl11	108	32	Manual transport, Movements with Efforts and Stress
Cl12	355	39	Objects handling, movements and cutting
CL13	140	32	Working machinery, Breking or Contact, Varoius injuries

SKM identified substantially the same groups of occupational accidents for the two sub set analyzed.
All the families identified marked a downgrade in term of number of events from the period ante to the period post 81/2008 emission. The 81/2008 didn't change dramatically the occupational accidents domain in term of occupational accidents dynamic distributions.

4. Conclusions

A large-scale study based on the analysis of general factors was done with the aim of analyzing the effectiveness of most recent national safety regulation on work safety improvement.
The study was focused on 2006-2013 period in Piemonte, a north west region of Italy with a large and traditional FDI. The results of this study highlights that the occupational accidents number in FDI dropped strongly after the 2008 with a loss of the 50% of events.
A connection of time with the emission of Dlgs 81/08 was identified but an accurate estimation of the contribution of the National Regulation wasn't done because some factors cannot be actually quantified.
Distribution of occupational accidents and average seriousness as regards to enterprise size highlighted how the FDI business structure is deeply characterized by the presence of micro enterprises.
Analysis performed with SKM allowed to identified the groups of accidents with similar characteristics.

The comparison of the results of two period analyzed suggested that the National Regulation wasn't able to modify radically the distribution of occupational accidents dynamic. The relative accidents frequency reduction was larger in Large companies than in micro and small enterprises for which issues of health and safety are not seen as important for the business success (Vassie et al., 1998). This information suggest that any policy of safety improvement should be targeted to small-sized industries.
This study will be expanded with a more detailed analysis of macro-economic factors including information related to the worked hours trend and wage guarantee funds trend.

Acknowledgments

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