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A STUDY ON SAFETY COSTS IMPACT

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Abstract: *Safety costs are difficult to estimate or calculate because not only direct and indirect costs have to be considered, but also, "expected" and "unexpected" one. Thus, even in the specialized literature presents few studies on the effects of prevention costs in the field of occupational health and safety (OHS). In this context, the present article aims to contribute to the extension of the knowledge base regarding safety costs by investigating the relationship between OHS prevention costs and the accidents costs. The empirical research carried out is based on the survey technique, and the research tool used is a questionnaire that was developed and applied to a group of companies from the Western Region of Romania. The research sample consists of 62 companies (11 of which have a management system OHS 18001 certification), and the data collected through the questionnaire are statistically analyzed, resulting the modeling of the structural equations that characterize the investigated relationship. The research result indicated that the companies' investments in OHS prevention actions (mirrored by the costs of prevention) have a significant positive effect on the cost savings associated with work accidents.*

Key words: *occupational health and safety, OHS costs, safety costs, prevention costs, accidents costs, statistical analysis, structural equation.*

1. INTRODUCTION

Safety performance and management have a significant impact on the operation and performance of manufacturing systems, on companies; safety performance is most of the time neglected and verified only if an accident occurs of during the final commissioning [1].

Occupational health and safety management (OHSM) practices, based on preventive behavior of both employees and employer, are supported and strongly encouraged by the standard OHSAS 18001:2007 which creates a structural approach to OHSM systems, and certification procedure. Companies of different type and from different business sectors implement the standard considering this as an opportunity for their official statement on OHS [2; 3]. In addition, studies in the literature have proved that countries with the highest OHS preoccupations and implementations are those with the highest competitive power [4].

For several years, researches and practitioners in the field of OHS have recognized the importance of safety culture in creating a preventive behavior of all employees. Thus, the main generalized concerned refers to the creation of a balance between the effort in the field of OHS (expressed through the investment costs allocated to the prevention actions) and the occupational accidents or incidents costs, associated to the different types of losses these events cause [5].

"The loss of human resources that occurs when employees do not take part in production processes permanently or temporarily because of accidents taking place in a workplace is an important cost element for a company" [6]. "However, prevention costs have a potential to prevent occupational accident injuries, decrease employer's costs and increase employer's profits" [7]. Researchers state that costs-related accidents resulting from not taking OHS measures are much higher than costs-related to OHS prevention; thus, from economic reasons there is justified to invest on the prevention actions and initiatives in OHS [8; 9; 10; 11; 12; 13]. Furthermore, from the findings presented in the literature, it has been shown that providing safety and healthier workplaces increases

employee's productivity and satisfaction, creating the occupational wellbeing [6; 9; 14].

Like the total quality management (TQM) system, OHSM system is concerned with employee satisfaction. "One of the reasons for the increased importance of employee satisfaction is the close association between this concept and employees' OHS and productivity in work" [9], both being factors of development of the work-place well-being [6; 14].

OHS could contribute to the elimination of negative effects as the rising of "economic costs or unproductive working caused by increased work stoppage, absenteeism and turnover rate" [5; 14]. Furthermore, from the perspective of non-wage factors related to job dissatisfaction could negatively affect labor productivity and turnover, the absenteeism and occupational accidents [8; 9; 15].

Because the related costs of OHS are somehow difficult to be calculated or estimated, in the literature there are a limited number of researches related to the prevention costs "impact on safety culture, employee satisfaction and accidents costs" [9]. The research of Fernández-Muñiz et al. [6] mention that employers consider prevention costs un-useful, missing their contribution for OHS improvement, thinking that they do not positively affect the productivity but having negative effects on company's profitability and competitiveness (sample consists of companies from Spain) [6]. Furthermore, the researches of Bayram and his colleagues (2017, 2018), developed on a sample population from Turkish companies, demonstrate "that there is an indirect relationship between prevention costs and accident costs [8; 9]; OHS prevention costs have a direct effect on safety performance", similar to the results of a study developed in Spain [16].

The few studies in the literature on safety costs effects support the idea "that contrary to the common belief of managers, there is a good return of investment on OHS" [9] and this fact must encourage employers to invest in OHS [17].

Furthermore, at the organization level, managers have recognized that setting a track of safety costs is not an easy approach but a time-consuming process. "No two organizations are going to arrive at the same costs, even if they both choose, measure, and count the same items as components of safety costs" [18]. In addition, it is complicate to determine if the costs are justified or not, but from the practical point of view there have been recognized that when "done properly, safety efforts prevent incidents. Over time, the benefit of preempting incidents begins to have a less obvious cost benefit as incidents become fewer. Thus, collecting good data in the early implementation phases becomes a factor in continuing to demonstrate value over time. There are many ways to determine an organization's cost of safety" [17; 18; 19; 20].

In addition, the easy way on started to collect data and track the safety costs is by considering the two sub-categories of related costs: (1) the cost of supporting the safety of the company's activities (most related to the prevention cost and investments in the field of OHS) and (2) the non-safety costs (related to occupational diseases and work accidents). The two costs categories help company on monitoring and control investments in OHS, operate on cost efficiency and on eliminating the identified costs of non-safety [14; 16].

The costs related to assure the safety of the company's activities need to be correct and clear described, and "they can be simple or extensive, depending on the degree of detail desired in cost data (e.g., in some organizations, all training is included as a safety-producing activity, in others, only safety-specific training is included)" [18]. The costs related to assure the safety of activities are usually considered as direct costs [4; 17; 21].

From the practical point of view, "non-safety costs are those expenditures resulting from a lack of safety, such as accidents, incidents, and lawsuits. They must be included to gain a complete picture of safety-related expenses" [18]. This cost category is sometime considered as indirect cost that consists of direct costs of accidents (expenditure for human heath recovery, machine and environment remediation, rebuild etc.), but also other costs as those related to penalties, to the loss of "productivity, diverted management attention, accident investigation, delays, and such that amount to around four times the direct costs" [18]. There have been observed that, with serious accidents, these expenses can rise to 10-

15 times the direct costs, especially if litigation ensues [11; 17; 22].

The overall accepted mathematical model for OHS cost calculations is shown in the following (according to the research of [9; 23]):

$$Safety\ cost\ (SC) = Prevention\ cost\ (PC) + Accident\ cost\ (AC) \quad (1)$$

The literature in the field of safety cost is poor and limited to some industries as construction and civil engineering fields, and the automotive, manufacturing filed in generally [23; 24]. A relevant study [19] developed a cost model that measures and assesses trends in total occupational safety costs by time. Studies have underlined that failure and accidents costs decrease as OHS prevention costs increase because more expenses are made on risk mitigation [19; 24]. Consequently, investing in OHS costs has positive effects and different approaches on using cost-benefit analysis demonstrates this fact [20; 21].

In this context, the aim of this article is to present an empirical study that investigate the relation between the safety preventive costs and the accidents costs. Thus, the results may encourage managers to seriously consider the effectiveness and efficiency of investing in OHS.

The most important contributions of this study to the literature is related to the development of a new scale for accident costs and prevention costs. The paper structure is defined by the following sections: (1) presentation of the research methodology; (2) research results and debates; (3) conclusions.

2. RESEARCH METHODOLOGY

2.1 The research hypothesis establishment

According to previous research results in the literature and to statistics, investment in OHS associated to prevention costs yields a profit of approximately 1:1–1:10 in return [8; 9; 25]. "Research on the construction sector in England reports that the total benefit gained by preventing occupational accidents is three times as much as the expenses incurred by accidents" [10]. In addition, there has been demonstrated "the benefits of investing in OHS as cost saving as a result of decreasing the number of work accidents, fewer interruptions in production and increased productivity" [25]. Similar findings and arguments of the importance of safety prevention costs are shown by [8; 9; 20; 26].

"According to the European Agency for Safety and Health at Work, the benefits to be gained through investment in health and safety fall into two groups" [26]:

- "Among direct benefits are reduce insurance premiums, reduced sue charges, reduced sick pay costs, improved production and productivity rates, reduced product and material damages, and reduced accident costs and production lags";
- "Some indirect benefits, on the other hand, are reduced absenteeism, reduced personnel, improved corporate image, convenience in winning tender, and improved job satisfaction and morale".

These few arguments show that OHS investments in prevention (assimilated with related costs) have a positive impact on the companies' performance in the field of occupational and health and safety, mainly by saving the possible occurred accident cost and thus, increasing employee satisfaction with their jobs, professional activities in the company and with the activities related to their workplaces, in general (*research hypothesis*).

2.2. Defining the research methodology

The research model has been developed based on the literature review (Figure 1). The research hypothesis was related to the supposition that the higher the OHS prevention costs are, the higher the savings in accident costs will be.

The research methodology is a survey based on a questionnaire that have been used for similar study by [8; 9]. The structure of the survey consists of 2 parts: one dedicated to dimensions or aspects f safety preventive costs and the second one dedicated to accidents costs issues, as depicted in Figure 1 (including the codification of each item).

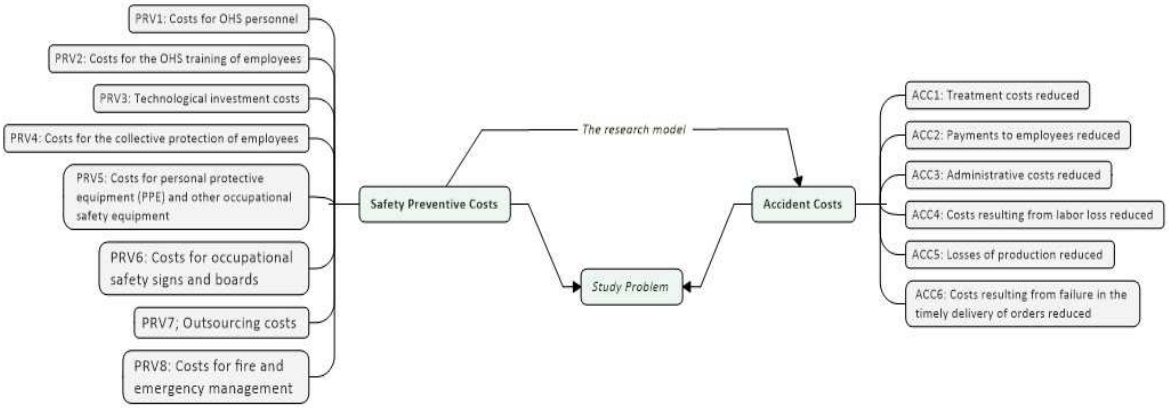
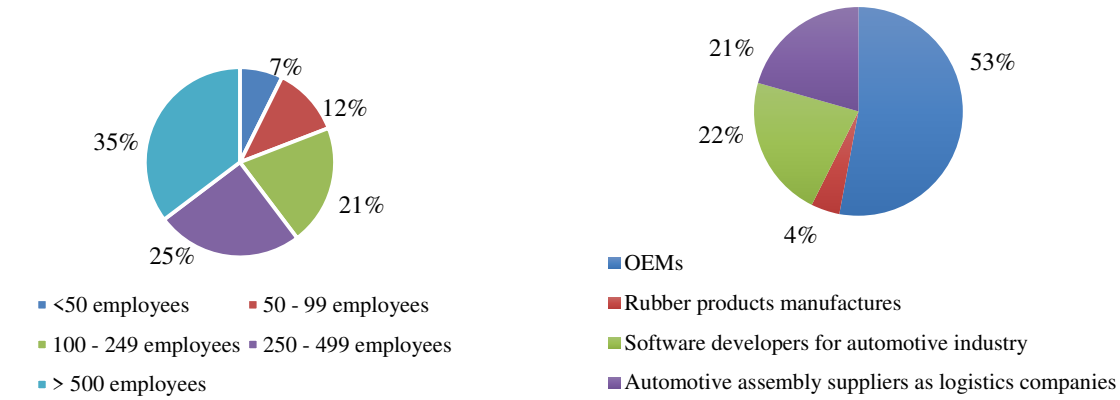


Fig. 1. The research model



a. Sample structure by companies' size

b. Sample structure by type of economic activity.

Fig. 2. The research sample structure

In the survey, the respondents were asked to express their opinions on each item (as they know and as they perceived the existing situation in the company they belong at) by using the associate scale (present in each question):

- The "accidents costs" scale was a 5-point Likert-type scale (1 - strongly disagree, …, 5 - strongly agree);
- For the items related to the "safety prevention costs", a different 5-point Likert scale was used "(1 - no expense, 2 - as little expense as possible, 3 - as much expense as required for fulfilling minimum legal requirements, 4 - as much expense as required for completely fulfilling legal requirements and OHS management system requirements and 5 - as much expense as required for achieving zero accident target besides fulfilling legal requirements and OHS management system requirements)" [2; 3].

There have been observed that the literature contains few studies on OHS prevention costs [8; 9; 19; 20; 23; 26] and there were no available many scales that could inspire the research design (survey-based research). "The 8-item scale for OHS prevention cost" (PRV1, …, PRV8 in Figure 1) was developed based on the studies [8; 9]. "The 6-item scale for "accident cost"" (ACC1, …, ACC6 in Table 1)) was similar as those developed based by [8; 9].

The research sample demographic characteristics are shown in Figure 2. Initially, the questionnaire has been sent via e-mail and through face-to-face meetings to 120 companies' managers and OHS managers, mainly multinational and from the automotive industry in Timisoara and Arad city areas in the West Region of Romania (direct distribution of the questionnaires and the direct responses

collection have been facilitated by our master students that are also employees of such companies). In addition, some OHS consultants were considered in the target group because they are external OHS experts for important automotive companies (their answers were related to the companies). A total of 68 valid complete fill-up questionnaires have been subjected to the statistical analysis. The response rate was 56.67% (68/120) which is considered a very good one. Only, 12 of the companies included in the sample has an OHSAS 18001:2007 certificate and the good response rate has been achieved because of direct connections and researchers' involvement in the questionnaire distribution and collection phase.

3. RESULTS AND DISCUSSIONS

We followed the approach suggested by [8; 9] in examining the scales regarding "unidimensionality, internal consistency, composite reliability and convergent and discriminant validity. The presented results were achieved in two phases:

1. The explanatory factor analysis that assessed whether the items for each construct shared one underlying factor;
2. The confirmatory factor analysis that assessed the convergent validity of the measurement model. Convergent validity was used to show that measures which should be related to reality".

3.1. The exploratory phase analysis

The exploratory phase analysis (developed by using the facilities of SPSS software) will be presented, together with relevant conclusions. In this stage of research has been considered "each construct in order to assess whether the items for each latent construct shared one underlying factor".

Based on the research methodology suggested by [8; 9; 27], the exploratory study has been performed a Vari-Max rotation. Before, a Bartlett's test of sphericity to investigate the factorability of the data, and the Kaiser–Meyer–Olkin (KMO) test to measure the adequacy of sample. The research results were similar with those of [8; 9]:

- A significant test statistic for Bartlett's test of sphericity, $p < 0.001$;
- KMO value of 0.930, meaning that the data were suitable for structure detection (sample was adequate);
- Items with a factor loading below 0.4 and items strongly loading on more than one factor (>0.400) were excluded. Thus, resulted two factors with an eigenvalue >1 which explained 41.42% of the total variance:
  a) For PRV safety preventive costs factors, eigenvalue is 6.45 and accounting for the 35.64% of the total variance, included 8 items;
  b) For ACC accidents costs factors, eigenvalue is 1.752 and accounting for 5.78% of the total variance, included 6 items.

3.2. The confirmatory factor analysis

"Convergent validity analysis of the scales is contingent on the fulfillment of three criteria" or conditions [9]:

(a) "all indicator loadings should exceed 0.703;
(b) composite reliabilities (CR) should exceed 0.8 or alternatively Cronbach's α should exceed 0.65 (α can theoretically take values from 0 to 1); and
(c) the average variance extracted (AVE) for each construct should exceed 0.5".

The psychometric properties of the constructs are presented in Table 1. As can be seen, all the indicator loadings are above the recommended threshold.

To evaluate discriminant validity, [9] "suggest that the square root of AVE of a latent variable should be greater that the correlations between the rest of the latent variables. Table 1 presents the correlation of latent variables and the square root of AVE. A comparison of all the correlations and square roots of AVE on the diagonal indicates adequate discriminant validity for all constructs. In addition, the confirmatory factor analysis shows that the loading of each indicator is greater than all its cross-loadings, which indicates discriminant validity on the indicator level".

Furthermore, there have been an interest on representing the structural model of the research.

"The cross-validated communality (CV-communality) measures the capacity of the model to predict the manifest variables (MVs) directly from their latent variables (LVs) by cross-validation. It uses only the measurement model. The prediction of an MV of an endogenous block is carried out using the MVs of the same block" (like the previous research results of [9]).

Table 1

Calculation results of the psychometric properties of constructs and items.

Statistics indicators	**Prevention costs variable / constructs**							
	PRV1	PRV2	PRV3	PRV4	PRV5	PRV6	PRV7	PRV8
Mean	3.94	3.94	3.90	3.90	3.94	3.94	3.87	3.99
Std. Dev.	0.75	0.90	0.93	0.99	0.99	0.81	0.77	0.87
Std. Err	0.09	0.11	0.11	0.12	0.12	0.10	0.09	0.11
df.	67	67	67	67	67	67	67	67
t	15.83	13.27	12.35	11.58	12.00	14.70	14.63	14.04
Cronbach's α	0.682							
CR	0.904							
AVE	0.504							
Statistics indicators	**Accident costs variable / constructs**							
	ACC1	**ACC2**	**SCC3**	**ACC4**	**ACC5**	**ACC6**		
Mean	3.69	3.34	2.97	2.75	3.40	3.65		
Std. Dev.	1.07	1.13	1.09	1.18	0.78	0.91		
Std. Err	0.13	0.14	0.13	0.14	0.09	0.11		
df.	67	67	67	67	67	67		
t	9.19	6.13	3.55	1.75	9.54	10.39		
Cronbach's α	0.652							
CR	0.803							
AVE	0.530							

Std. Dev. – standard deviation; Std. Err – standard error; df. – degree of freedom; t – value of the t student test; AVE - average variance extracted; CR - composite reliability

Table 2

Results of the confirmatory factor analysis.

Correlation of latent variables and square root of average variance extracted (AVE).		
	ACC	**PRV**
ACC	0.890	0.780
PRV	0.287*	0.808
*p < 0.010		
Quality of measurement and structural model.		
	CV-communality	**CV-redundancy**
PRV	0.552	0.322
ACC	0.597	0.233

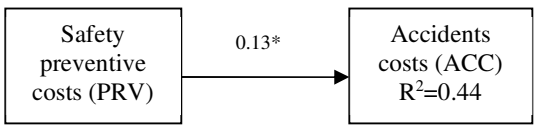


Fig. 3. The structural model (*p < 0.050).

The cross-validated redundancy (as seen in the second part of Table 2 with details for CV-redundancy) has demonstrated the capacity of the path model to predict the endogenous manifest variables indirectly from a prediction of their own latent variables using the related structural relation, by cross validation [22] and thus, this is also a proof of the structural model quality.

7. CONCLUSIONS

The presented research was aimed to study the relationship between safety prevention costs and accidents costs using a survey based on a questionnaire (adopted by from the previous work of [8; 9], results being generated through an explanatory and confirmatory factors analyses (based on the facilities offer by SPSS software tool).

The empirical research findings confirm that there is a direct positive relationship between OHS prevention costs and decrease in accidents costs. This result is consistent with the findings of Ikpe et al. in 2011 [10], of Falkner et al. in 2012 [28] and of Bayram et al., in 2017 [8] and 2018 [8]. Furthermore, findings of this study prove that, contrary to the common belief of managers, there is a good return of investment

on OHS, and it is hoped that the findings of the present study will encourage the employers to invest in OHS. Thus, the research results empirically demonstrate that managers that have positive safety cultures by investing in OHSM can experience significant decreases of the cost related accidents in their companies.

The research limitations are related to the research context and the methodological approach (when interpreting the results); this study was conducted in the West Region of Romania (with a sample of 68 companies), which is characterized as a high developed one in the field of automotive industry, thus having a develop safety culture. Therefore, research conclusions may be difficult to extrapolate to the whole country and other [28; 29]. In the future, we propose to extend the studies on the case of a specific industrial sector (e.g., the automotive industry which is most represented by foreign investments in the West Region of Romania, or similar to [29]) and also, in the case of the small and medium size enterprises with a poor safety performance. In addition, the present and future studies will promote to the companies the idea of having a OHS management system certification, thus demonstrating the usefulness of the OHSAS 18000 standard application (currently, less companies in Romania are certified and a research on certification implications on safety costs will allow managers to better support their decisions in the field).

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Un studiu asupra impactului costurilor securității în muncă

Rezumat: Costurile securității muncii sunt dificil de estimat sau calculat; literatura de specialitate prezintă puține studii privind efectele costurilor de prevenție în domeniul sănătății și securității în muncă (SSM). Prezentul articol investighează relația dintre costurile de prevenție ale SSM și costurile accidentelor. Cercetarea empirică realizată are la bază tehnica sondajului, iar mijlocul de investigare folosit este un chestionar ce a fost dezvoltat și aplicat unui grup de companii din Regiunea de Vest a României. Eșantionul cercetării este format din 62 de companii (dintre care 21 care au certificare a sistemului de management conform cu standardul OHS 18001), iar datele colectate prin intermediul chestionarului sunt analizate statistic, rezultând astfel modelarea ecuațiilor structural ce caracterizează relația investigată. Rezultatele obținute au indicat faptul că investițiile companiilor în acțiuni de prevenție în domeniul SSM (cuantificate prin costurile de prevenție) au un efect pozitiv semnificativ asupra economiilor de costuri asociate accidentelor de muncă.

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