Prospectiva de gestión de riesgos industriales en México con el uso de drones

Prospective management of industrial risks with the use of drones in Mexico

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Resumen

La elaboración de escenarios futuros representa un ejercicio enriquecedor y, sin duda, es una actividad necesaria para la planeación a largo plazo. Su propósito es establecer una situación problemática, por ejemplo, la identificación de peligros dentro del proceso de gestión de riesgos en seguridad industrial en México, y la manera como se pueden obtener beneficios al adoptar la tecnología de drones y evitar accidentes con la identificación y eliminación de sus causas. La presente investigación se hizo de acuerdo a Cisco y GBN, mediante preguntas realizadas a expertos y personal de las empresas sobre el tema y otros afines; asimismo, se desarrollaron cuatro historias futuras acerca del tema de estudios: el escenario inseguro, el escenario corrupto, los escenarios drásticos y los escenarios de resurrección.

Palabras clave: prospectiva estratégica, Vehículos Aéreos No Tripulados (UAV), gestión de riesgo laboral.

Abstract

The development of future scenarios represents an enriching exercise, and is certainly a necessary activity for long-term planning. Its purpose is to establish a problematic situation, for example, the identification of hazards in the process of risk management in industrial safety in Mexico, and how you can obtain benefits to adopt the technology of drones and avoid accidents with the identification and elimination of their causes. The present research is made according to Cisco and GBN, through questions made to experts and company's staff, about the issue and related topics; also developed four future stories about the subject of studies: unsafe stage, the corrupt scenario, the drastic and scenarios of resurrection.

Key words: strategic foresight, Unmanned aerial vehicles (UAV), occupational risk management.

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Introduction

Currently companies make use of studies of strategic foresight for: generating and evaluating its strategic options, make forecasts of oil to see the excess capacity in the business, explore the future development of a country, estimate the future of environmental responsibility, anticipate contingent health care costs control and regulatory control, evaluate the consequences of deregulation in electric companies, determine the changing dimensions of competition in financial services, develop a strategic vision for a division of R + D, help Wall Street analysts see future changes in industries that make a follow-up, and so on.

Every administrator of an industry or responsible for the security of his/her company, will have ever wondered, ¿do the unmanned aerial vehicles or drones will help in the prevention of industrial risks for the achievement of the goal zero accidents? One of the great challenges in industries is the competitiveness and a way to achieve it is to work at the frontiers of productivity, allowing to ensure the optimization of processes. Currently, companies operate increasingly in an interconnected and globalized world; the demands of customers, emerging markets and new

competitors are evolving at a rapid pace, giving rise to a dynamic capable of impacting any business either positive or negative. Organizations must be more adaptable, innovative and inspiring, without losing sight of its focus, discipline, and performance. Managers must be ready to compete in two levels; on the one hand, they must exploit immediately the opportunities that are presented; on the other hand, they must examine how can adapt to the evolution of larger periods and, above all, optimize the resources allocated to reduce costs and get more benefits and better competitive advantages, making more profitable and sustainable businesses (Porter, 1991).

If a process of industrial safety achieved zero accident, therefore achieves zero accidents and zero deaths by accident costs, which is part of the great benefit of increased productivity and competitiveness of enterprises. Unfortunately it is observed that in many companies the industrial safety is not very safe, while there are many technological tools and information that can enhance the safety in industrial processes. It is estimated that nearly 160 million people suffer work-related diseases and that each year occur around 270 million fatal and non-fatal accidents; Likewise, the international of Labour Organization (ILO) estimates that result each year lost 4% of the Gross Domestic Product (GDP) worldwide (OIT, 2015).

Only in Mexico, the Ministry of labour and Social Welfare (STPS) reports that, during the year 2014, they recorded 409 thousand nationwide 248 work accidents (STPS, 2015); and in its annual report for the year 2013 on accidents and diseases at work estimated a 3% increase in accidents of work and 15% on disability employment, registering 2.56 accidents for every 100 workers and 6.07 disabilities every 100 cases. The activities with the highest incidence of risks and deaths were the construction of buildings, civil engineering works, and professional and technical services (STPS, 2013). Because of this, the protection of workers against occupational hazards, requires to any company, the implementation of a methodology for evaluation and business obligations, as well as the correction afterwards of situations of risk already established.

Hence the importance of the present work of research on the impact of a technological inclusion, such as drones (unmanned aerial vehicles UAV), in the industrial security process, the improvement of the management of occupational risks and the reduction of industrial accidents. From the approach of scenarios showing a possible better future in the process of industrial safety, this project sets out initial questions: what impact will the use of drones have as technological

inclusion in the process of industrial safety?, will drones help the industrial security process to reduce accidents and costs?

For it is presented from the beginning the current scenario of strategic foresight, industrial safety and context of occupational risk management and the use of unmanned aerial vehicles or drones as current and future technological inclusion for the prevention of industrial risks. Subsequently the impact and future of drones in the processes of industrial safety equipment companies in Mexico by the year 2025 proposed by establishing four future scenarios using this technique strategic scenario planning.

LITERARY REVIEW

Prospective strategic

One of the great tools of strategic planning is scenario planning, which functions as a methodological approach to predict and / or build futures, that achieved by identifying key trends and scenario building whose purpose is to help improve decisions and reduce risks in the organization (Vergara, Fontalvo, and Maza, 2010). Scenario planning is an analysis technique whose function is to reduce the uncertainty of the future. For this part of two fundamental principles: a) there is an almost infinite number of possible futures, and b) there is an almost unlimited number of variables that have the potential to affect the progress of the human group under analysis, whether an organization or a company.

Scenario planning is a method to imagine possible futures, companies apply in a variety of topics. It reduces the huge amount of data to a limited number of possible states, as each scenario shows how the various elements can interact under certain conditions. By formalizing relations it is possible for a company to develop quantitative models, which should be evaluated to determine the existing and possible consistency. Scenario planning identifies the richness and variety of possibilities, induces decision makers to consider changes and narrating for better understanding because they have the logic to question the prevailing mentality. Scenario planning does all this by dividing our knowledge in two areas: (1) the things we think we know, and (2) the elements that we consider uncertain or unknown (Schoemaker, 1995).

A situation where future planning are used is the simulation scenario analysis stochastically, for example, in case of seismic hazards future of small, moderate or extreme effect and possible future losses such as the expected annual loss and the maximum probable loss to thereby help decision makers plan for future emergencies, plan the reinforcement of buildings and financial protection, etc. (Salgado, Carreno, Barbat, and Cardona, 2015). The process of scenario planning consists of ten steps: 1) Define the scope, 2) Identify key stakeholders, 3) Identify the basic trends, 4) Identify basic uncertainties, 5) Build subjects of initial, 6 scenarios) Check coherence and plausibility, 7) Develop learning scenarios, 8) to identify research needs, 9) Develop quantitative models, and 10) Evolve toward scenarios decision. (Schoemaker, 1995). A scenario is a tool to help today to make decisions with some understanding of how they might be things in the future, so its operation is based on sketching different future, not restricted to a linear behavior as the scenarios should not be understood as something definitive, but rather as a starting point and an invitation to the discussion of a project and its construction (Friedrich Ebert Foundation, 2011).

Strategic scenario planning has been used for a long time by various organizations. A case of application of scenario planning presents very well the report provides a collaborative effort between Cisco and Global Business Network (GBN), consultancy scenarios most important in the world, whose research objective was the presentation of proposals 2025 on the potential of Internet use and large IP network infrastructure for economic and human development worldwide, taking into account that the Internet can be a source of innovation and creation of commercial, social and human value. It is important the definition of scenarios offered, ie, a set of divergent stories about the future (Cisco-GNB, 2010).

Industrial safety and context

When talking about industrial safety must be present a definition, so in this case the law of Industry (Law 21/1992) of the Ministry of Industry, Tourism and Trade of Spain, states that:

> Industrial safety is aimed at the prevention and limitation of risks and protection against accidents and accidents capable of causing damage or injury to people, flora, fauna, property or the environment, arising from industrial activity or use , operation and maintenance of facilities or equipment and production, use or consumption, storage or disposal of industrial products (Soria y Viñas, 2010).

It is noted that industrial safety is to ensure people and things, so, to fulfill this purpose, it is necessary that governments ensure compliance through the establishment of laws. For example, in the European Community (EU), the European Agency for the Administration of Occupational Safety and Health Administration (OSHA), established by the Law on Occupational Safety and Health, 1970, the duty of:

> Ensure a safe and healthy work for working men and women by authorizing the application of the standards developed under the Act; assist and encourage States in their efforts to ensure safe and healthy conditions of work; and provide research, information, education and training in occupational safety and health (OSHA, 2015).

A distant reality for many workers are the principles of protection from disease and accidents that has established the ILO as die each year about two million people die from diseases and industrial accidents (ILO, 2015) . With respect to the European Community, OSHA reports that every year 4,000 people at work and more than 3 million suffer serious accidents, and that the cost to workers, companies and Member States is about 3% of EU GDP (OSHA, 2015). In Mexico, the Mexican Social Security Institute (IMSS) has reported 422,000 cases of accidents and illnesses and deaths 1314 (Social, 2013); it is important to note that in Mexico about half of workers are not affiliated to the IMSS, so lacking occupational risk insurance and therefore are not considered in the statistics.

Occupational risk management

Regarding the term risk, this has different connotations, such as the existence of a hypothetical future injury, or a difficult event to identify and characterize. That is, if in a given situation is not a risk factor, this can be considered controlled, but not eliminated since there may be other conditions that can detonate it is detected. So, it is not easy to determine the magnitude of a risk, so there is vast literature on risk management and its impact. Jannadi and Almishari (2003) define risk as a measure of probability, severity and exposure to the dangers of an activity. Meanwhile, Salla and Sanna (2008) classify into three groups, those related to ergonomics, labor and the environment. Other studies have focused on community based projects (Manelele and Muya, 2008).

A management process occupational risk involves two basic activities: a) the risk assessment, which involves the question is it safe work situation ?, ie it must respond to this question by performing the process of risk analysis , which is aimed at identifying the danger and the estimation of risk (order of magnitude of risk), then perform risk assessment; and b) risk control, what happens if the work situation is not safe? It proceeds to step risk assessment to decide whether the order of magnitude is tolerable or not tolerable, and the value of risk with the value of tolerable risk is compared, If you were to determine that the risk is not tolerable, it is important then to apply control measures (Romero, 2005).

UAVs as technological inclusion in risk prevention

Unmanned aerial vehicles or drones called aerial robots is a current technology that has facilitated various missions worldwide. This technology was created and applied to military environments since World War (Monsoon Catalan, 2013). However, advances in microelectronics have allowed the development of smaller devices for civilian use. Michael Brooks (2012) mentions that the history of these teams started from the application of a gyroscopic stabilizer to convert a biplane in the first controlled radio control UAVs, to control them via a smartphone (Mossel et al., 2014). Among the benefits generated by the use of this technology in the units manned by highly trained pilots is greater safety for operators and faster deployment for emergencies (Rank et al., 2006). Meanwhile, Ten (2013) agrees that are useful in areas of difficult geographic access, public order, or volcanoes, fire, radioactivity concentration, among others. Provide the ease of taking high-resolution aerial photographs even under cloud cover, however, also they offer vulnerability, difficulty airspace integration, weight limitations, and so on.

Although the military has employed drones for decades, its availability in scientific and civilian applications continues to modernize. In a recent publication of Watts, Ambrosia, and Hinkley (2012) the chronological development of major applications in different industrial and civil environments shown. However, according to Rosales et al., (2011) can be mentioned that the main applications of the drones are monitoring road traffic, operations air search and rescue, gathering information for weather prediction or detection of fire; while Joan (Carles Ambrojo, 2013) says that applications, for example in Japan, are used to control the level of radiation from the

Fukushima nuclear power plant, or to help in areas as diverse as the revision of powerline activities, the state of the buildings, the impact of the works, and so on.

The use of this technology seems to be focused on the implementation of systems that generate a competitive advantage because of its scope, which allows them to travel by land and air, over rough and rugged terrain, overcome any obstacle and generating an aerial view, plus a low cost compared to other teams, for example, traditional helicopters, threatening the human factor. In this sense, the changing workplace practices and work processes generate new risks and challenges to workers and companies, who in turn demand political, administrative and technical approaches to ensure high levels of safety and health at work (Risks , 2014).

METHODOLOGY

This work is descriptive with qualitative approach, because it is designed to comprise four future scenarios of drones as technological inclusion in the process of identifying risks in the management of industrial safety in Mexico. Data were collected on a single occasion and for a specified time. The first step was to clearly understand the system under study (industrial-safety risk identification) and the second developing scenario planning. the problem definition, the purpose of scenarios and contradictions raised for the study, which are presented below: To achieve understanding of the system under study the following basic aspects were established.

Problem

In Mexico each year a large number of accidents is generated. During the year 2013 were recorded at the national level 415 000 660 accidents and in 2014 recorded 409 000 248, while the number of workers affiliated to the Mexican Social Security Institute increased 3.6% compared to 2013 (STPS, 2015). Accidents are caused by basic causes (personal factors and work factors) and immediate causes (unsafe acts and unsafe conditions). Such accidents can be avoided, so it is essential to make efforts to identify and eliminate the underlying causes. Everything that is done in favor of risk prevention work is key to achieving zero accidents (Department of Labor, 2015).

Purpose of scenarios

It is established that the type of purpose is strategic conversation, because you want to drive continuous process improvement of industrial safety.

Contradictions

1) Today, with so much technology, including drones, companies can not ensure unsafe conditions to avoid accidents.

2) Industrial safety is not very safe with many existing technology inclusions.

3) There is a lot Industrial insecurity even though there is a lot of technology to secure it.

For the second step (scenario planning), developed the process steps followed Cisco and GBN in the research study proposals 2025 on the potential use of internet (Cisco-GNB, 2010). These steps in the process are:

a. Set questions.
b. Show the industrial safety system.
c. Review scientific literature, materials and associated legislation.
d. Interviewing expert scientists, heads of industrial safety area, coordinators and supervisors as well as workers.
e. Set premises.
f. Making environmental analysis.
g. Set the influence factors and uncertainty analysis for the use of drones in industrial safety over the next ten years.
h. Determine the most influential key factors.
i. Set axes of uncertainty.
j. Define future scenarios.
k. Reach conclusions.

RESULTS

Results to the process were:

Set questions

The initial questions were: drones will help in preventing industrial risks to achieving zero accidents?, have a big impact the use of drones as technological inclusion in the process of industrial safety ?, drones process auxiliarán industrial safety to achieve the reduction of accidents and accident costs?

Show the industrial safety system

It was noted that industrial safety are often distinguished three levels of actions: 1. The Occupational Safety or Occupational; 2. Safety Serious Accidents; and 3. The Industrial Product Safety and Industrial Facilities. As a result the three levels of performance along with industrial safety industrial hygiene distinguished, they are two industrial activities that usually go hand in hand in order to prevent and avoid accidents.

Review of scientific literature, materials and associated legislation

Throughout the document (problem definition and background) you can see some of the materials and consulted literature for the study, which consisted of information from international and national organizations related to industrial safety and labor legislation, for example, the International Organization Labour Organization (ILO), the Agency for Safety and Health at Work (OSHA), the Secretariat of Labor and Social Welfare (STPS) and the Mexican Social Security Institute (IMSS), among others; basic authors on Strategic Planning and Scenario Planning, as Michael Porter, Clayton Paul JH Schoemaker Chistensen or also consulted; besides authors related to technological innovation and technology, such as inclusion: Adams Watts, John Villasenor or Claudio Rosales. In the section of references all literature and materials related to this study notes. In addition, other materials and information via different Web pages and related to the topic through periodic on-line news consulted: However, La Jornada and the world.

Interviews with scientific experts, heads of industrial safety area, coordinators and supervisors and workers

At this point we proceeded to design two sources of information gathering. The first was a survey with 10 reagents was applied to 100 workers (staff and supervisors) related to industrial safety in companies in the city of Puebla, Mexico. his opinion about the drones were asked about their importance, impact and technological inclusion in future as industrial safety. On the other hand, a dash-depth interview with 13 reagents which 15 people using Google forms via email and Facebook, targeting key stakeholders involved in the process of industrial safety was applied, such as it was also designed : security managers, industrial managers, academics, experts on the topic, members of government institutions devoted to the subject of industrial safety and technological designers. This took place during the month of October 2015.

Establishment of premises

The premises established by including drones allowed guide the development of future scenarios of the process of industrial safety. These premises were established from three aspects: the premises based on the operation, based on the assumptions and premises economy based on social and labor perception (see Table 1).

Table 1: Establishment of premises

Premisa de operación	+ Las empresas que integren como una estrategia drones al proceso de seguridad industrial, lograrán asegurar una efectividad operacional (EO) en sus unidades básicas, además de poseer ventaja competitiva (Porter, 1996). + Realizar cambios innovadores con enfoque disruptivo en los procesos de seguridad industrial permitirá ejercer un fuerte impacto en la disminución de accidentes (Christensen y Overdorf, 2000).
Premisa Económica	+ La adecuada identificación de riesgos utilizando la inclusión tecnológica basada en drones provocará la disminución de accidentes que mejorará la pérdida del 4 % del Producto Interno Bruto (PIB) anual mundial (OIT, 2015).
Premisa social	+ Los accidentes se pueden evitar, por lo que es imprescindible hacer esfuerzos para integrar a la tecnología en el proceso de seguridad industrial, y así identificar y eliminar las causas que provocan los accidentes; todo lo que se haga en favor de la prevención de riesgos de trabajo será clave para lograr el anhelo de cero accidentes (Dirección del Trabajo, 2015).
Premisa laboral	+ Los trabajadores (entrevistados) consideran que existe poco presupuesto en las empresas mexicanas para la inversión y capacitación tecnológica. + Los empleados opinan que en el sector gubernamental, la corrupción, los sindicatos y la falta de organismos regulatorios es una incertidumbre que a muchos les causa inquietud. + La mayoría considera que la mayor parte de la población es ignorante y con falta de cultura en cuanto a la inseguridad, además de que los trabajos explotados son un factor que aumenta los accidentes.

Source: elaboración propia.

Environmental analysis

On the one hand, we proceeded to perform the environmental analysis of macro strategic external operating environment, industry and micro strategic internal operating environment for the inclusion of drones in the process of industrial safety, where he settled analyze and externally identify opportunities strategic and threats in the operating environment (Hill and Jones, 2011), and on the other hand, an analysis within a company that uses a process Industrial safety was conducted, where the functions of resources are observed, skills and competences they play (Hitt, Ireland, and Hoskisson, 2008). A PEST analysis and SWOT-analysis: For this purpose two basic tools were used.

It is noteworthy that the PEST-A macroeconomic analysis establishes observation of political, economic, social, technological and environmental factors. These factors are external and are beyond the control of enterprises, and can occur as opportunities favorably or negatively as threats (Ballen, 2012). For the preparation of PEST Analysis-A split of the approach set out the impacts of macro-environment factors can have on the processes of industrial safety and use of technologies such as drones. After adding the responses to internal interviews and responses to respondents on factors and / or aspects, it could generate a sub-factor analysis in terms of the implications or impacts the most influential factor for each macro environment.

In this case, the research team in order to make a better analysis, established six sub-factors for political factor, 6 for economic factor, 2 for technological factor, 3 for the social factor and 2 for the factor environmental. In total they were established 19 sub-factors. The next step of the analysis was to establish the impact profile factors PEST-A taking into account the factors and sub-factors, and setting using a Likert scale weighting ranging from: not very impressive (with a numerical rating 1) bit shocking (rated 2), mildly shocking (rated 3), shocking (rated 4), and very impressive (rated 5).

For the preparation of the SWOT matrix, first the information yielded by the survey responses and interviews with employees of companies concentrated, so it could be observed that have six strengths that show the importance and impact that is thought to have drones in the process of industrial safety such as increased industrial safety, productivity, and cost reduction and industrial risks; on the contrary, three possible weaknesses that have to do with technology costs, resistance of workers and unemployment are observed. On the other hand, four times that technological

inclusion proposal (drones) can leverage to integrate the process of industrial safety and the other category two strong threats related to the government and its policies are observed are presented.

Establishment of the influencing factors and uncertainty analysis for the use of drones in industrial safety in the next 10 years (2015-2025)

Thanks to all the factors found, the research team established 25 key factors and their kind of influence (political, social, environmental, economic and technological). Then the most influential key factors were determined. Using brainstorming, team members identified the five most important factors for the use of drones in the process of industrial safety, considering that the level of impact derives from its importance (top 5 and 1 less important). Table 2 shows the five most influential factors.

Table 2. Most important factors.

Factor	Nivel de Impacto
Prevención de accidentes y ahorro de costos	5
Inclusión tecnológica y aumento de la productividad	4
Adquisición de tecnología (drones)	3
Políticas de gobierno flexibles y de apoyo	2
Desempleo y resistencia al cambio	1

Fuente: elaboración propia.

Set axes of uncertainty

For the establishment of the scenarios in turn three axes of great current uncertainty in the coming years and established (see Figure 1).

Figura 1. Ejes de Incertidumbre

Incertidumbre 1	Incertidumbre 2	Incertidumbre 3
• No sabemos a qué nivel de control el gobierno mexicano controlará y regulará el uso de drones en el proceso de seguridad industrial.	• No sabemos si habrá progreso tecnológico: inversión y capacitación. • La disparidad de las diferentes trayectorias se centran en: la elasticidad de los precios de los drones, la facilidad y uso, la oferta y demanda.	• No sabemos qué tanto los drones ayudarán en la disminución de los accidentes y costos de los msmos.

Fuente: elaboración propia.

Define future scenarios

Here are four absolutely plausible scenarios arise 2015 to 2025. The stories of the four scenarios obtained the shown in Figure 2, same as briefly develop quickly

Figure 2. The four scenarios

Fuente: elaboración propia con ayuda de imágenes Google.

1) Stage Inseguro.- A world that distrusts technology. The violation of privacy is the largest and most important concern of workers, followed by the carelessness of the operators of drones and drones vulnerability to cyber attacks themselves to get private data from other industries; there are many sanctions for breach of the use of drones. Companies struggle with competitiveness, especially small and medium enterprises that have financial problems do not invest in technologies such as drones.

2) Stage Corrupto.- Here the corruption of business and government go together and do not invest in new technology but for their own benefit. It is a scene of excesses and disloyalty because the search for personal gain, with high accident rates and costs. Companies have little or no supervision in industrial safety.

3) Stage Drástico.- technology generates unemployment. Technology investment reaches its peak potential by replacing labor by the use of technology, thanks to low costs of drones. Unemployment is generated and continues the economic crisis. Security supervisors are replaced by the use of drones and ICT. Employees are always intimidated and harassed by excessive monitoring and use of drones.

4) Stage Resurrección.- refers to action to revive, to improve to give better results. The resurrection is a symbol of transcendence in this scenario, the balance of the hand of man and technology where both elements can work efficiently and productively sought, generating greater

industrial safety and, above all, without incurring extreme measures . It moderate the use of technological inclusions such as drones, and this is used to ensure identification of potential risks that contribute to minimize accidents and lower costs thereof. From this part of the process ensures industrial safety and contributes to the competitiveness of enterprises.

CONCLUSIONS

Scenario planning is an analysis technique whose function is to reduce the uncertainty of the future. For this part of two fundamental principles: a) there is an almost infinite number of possible futures, b) there is an almost unlimited number of variables that have the potential to affect the progress of the human group under analysis, whether an organization or society. Scenario development represents an enriching exercise and certainly a necessary activity for long-term planning; therefore, in this project the construction of four scenarios was conducted to know the future of drones in the processes of industrial safety in Mexico. This exercise helps to identify the key factors in the development, place the central actors and fields of action or points of convergence which is built day by day the future and, therefore, is impinging on the path.

The purpose of this work was based on establishing a problem as is the industrial process industrial safety and how this can benefit from technology includes drones situation. The work was developed from questions to experts on the subject, and related, as well as interviewing and surveying the personnel working in enterprises. They were able to develop four future stories on the subject of study: the uncertain scenario, the scenario corrupt, drastic scenarios and scenarios resurrection. It is important to be aware that it is better to have several future scenarios in business, because the mere thought motivates the creation of better future than at present. A first step would be to analyze managers and know their maturity, their creative and innovative development in terms of forecasts and future predictions; then it could be proposed creating scenarios least ten years, after which possible strategies to achieve them would be established. All this of course using the methodology of scenario planning and strategic planning.

Bibliography

Ballén, X. R. (10 de 07 de 2012). Universidad Nacional de Colombia-Guía Análisis PEST (U. N. Colombia, Ed.) Recuperado el 28 de 10 de 2015, de http://www.bogota.unal.edu.co/objects/docs/Direccion/planeacion/Guia_Analisis_PEST.pdf

Brooks, M. (2012). The Drone Age. New Scientist, 42-46.

Carles Ambrojo, J. (2013). Los drones 'se alistan' al servicio civil. Técnica Industrial 303, 18-19.

Christensen, C., & Overdorf, M. (2000). Meeting the Challenge of Disruptive Change. Harvard Business Review, 52-60.

Cisco-GNB (2010). The Evolving Internet. San Francisco, CA.: Monitor/GBN Global Business Network.

Clarke, R. (2014). Understanding the Drone Epidemic. Chapman, Australia: Xamax Consultancy Pty Ltd.

Diez, C. A. (2013). Adquisición de imágenes de bajo costo aplicadas a la agricultura. Tesis. Quito, Perú: Universidad San Francisco de Quito.

Dirección del trabajo (25 de Septiembre de 2015). Dirección del trabajo/ Gobierno de Chile. Obtenido de http://www.dt.gob.cl/1601/w3-article-63152.html

Estadísticas y bases de datos, O. (8 de Junio de 2011). Estadísticas y bases de datos. Obtenido de Estadísticas y Bases de Datos, Organización Internacional del Trabajo: http://www.ilo.org/global/statistics-and-databases/langes/index.htm

Fundación Friedrich Ebert (Septiembre de 2011). Nuevos Enfoque de Desarrollo para México-Escenarios para 2020. Recuperado el 24 de Octubre de 2015, de http://library.fes.de/pdf-files/bueros/mexiko/08626.pdf

Hill, C. W., y Jones, G. R. (2011). Administración Estratégica (novena ed.), Mexico, D.F: Cengage Learning, Inc.

Hitt, M. A., Ireland, R., y Hoskisson, R. E. (2008). Administración Estratégica (séptima ed.). México, D.F: Cengage Learning, Inc.

Huerta Wong, J. E. (17 de Septiembre de 2015). Apuntes de planeación por escenarios. Puebla, Puebla, México: Posgrado Upaep.

Jannadi, O.A., Almishari, S. (2003). "Evaluación de riesgos en la construcción". Diario de Ingeniería y Gestión 129 (5), Construcción 492-500.

Jiménez Naruse, N. Y., y Alvear Galindo, M. G. (julio-agosto, 2005). Accidentes de trabajo: Un perfil general. Revista Facultad de Medicina de la UNAM, Vol.48, 139-146.

Manelele, I., Muya, M. (2008), "Risk identification on community-based construction projects in Zambia". Journal of Construction, Vol. 12 No. 1, pp. 2-7.

Monzón Catalán, I. (Septiembre de 2013). Desarrollo de un cuadricóptero operado por ROS. Tesis. Zaragoza, España.

Mossel, A., Leichtfried, M., Kaltenriner, C., & Kaufmann, H. (2014). Smart Copter: Enabling autonomous flight in indoor environments with a smartphone as on-board processing unit. International Journal of Pervasive Computing and Commun, 10, 92-114.

OIT (27 de 03 de 2015). Oficina Internacional del Trabajo. Recuperado el 27 de 03 de 2015, de http://www.ilo.org/public/libdoc/ilo/2004/104B09_309_span.pdf

OSHA (2 de 04 de 2015). Agencia Europea para la Seguridad y Salud en el Trabajo. Obtenido de https://osha.europa.eu/es/topics/riskassessment/definitions

OSHA (20 de Septiembre de 2015). Agencia Eurpea para la Seguridad y Salud en el Trabajo. Boletín para la Industria en General. Obtenido de https://www.osha.gov/Publications/OSHA3573.pdf

Pineda Rico, U. (2014). Plataforma Avanzada de Comunicaciones para Redes de mini-UAV (drones) Aplicadas a la Prevención, Control y Reacción Rápida en Situaciones de Emergencia. San Luis Potosí: Consejo Nacional de Ciencia y Tecnología (CONACyT).

Porter, M. E. (1991). La ventaja competitiva de las naciones. Buenos Aires, Argentina: Javier Vergara.

Porter, M. (1996). What is Strategy? Harvard Business, 59-78.

Rango, A., Laliberte, A., Steele, C., Herrick, J., Bestelmeyer, B., Schmugge, T., . . . Jenkins, V. (2006). Using Unmanned Aerial Vehicles for Rangelands: Current Applications and Future Potentials. Environmental Practice, 159-168.

Riesgos, O. E. (2014). Agencia Europea para la Seguridad y Salud en el Trabajo. Retrieved from https://osha.europa.eu/es/riskobservatory

Romero, J. C. (2005). Manual para la formación de nivel superior en prevención de riesgos laborales. Madrid, España: Diaz de Santos.

Rosales, C., Scaglia, G., Carelli, R., y Jordan, M. (2011). Seguimiento de trayectoria de un mini-helicóptero de cuatro rotores basado en métodos numéricos. XIV Reunión de Trabajo Procesamiento de la Información y Control, pp. 495 – 500, San Juan, Argentina.

Salgado, M., Carreño, L., Barbat, A., y Cardona, O. (2015). Evaluación probabilística del riesgo sístemico en Lorca mediante simulaciones de escenarios. Revista, 2-5.

Salla, L., Sanna, N. (2008). "Riesgos laborales en el mantenimiento industrial", Revista de la Calidad en Ingeniería de Mantenimiento, vol. 14 Iss 2 pp. 194-204.

Saari, J. (2001). Enciclopedia de Salud y Seguridad en el Trabajo. OSHA. En J. Saari, Enciclopedia de Salud y Seguridad en el Trabajo. OSHA (vol. II, parte 8), Madrid: Ministerio de Trabajo y Asuntos Sociales.

Social, I. M. (2013). Memoria Estadística (Base de riesgos de trabajo), México: IMSS.

Solís Carcaño, R. G., y Sosa Chagoyán, A. R. (2013). Gestión de riesgos de seguridad y salud en trabajos de construcción. Revista Educación en Ingeniería, 161-170.

Soria, J. V., y Viñas, J. A. (2010). Manual Para la Formación en Prevención de Riesgos Laborales. Programa preventivo para el desempeño de las funciones de nivel básico (sexta ed.), Valladolid, España: Lex Nova.

Schoemaker, P. J. (1995). Scenario Planning: A Toll for Strategic Trinking. MITsloan Management Review, 25-40.

STPS (1 de Agosto de 2015). Trabajo seguro "Boletin Electronico". Obtenido de http://trabajoseguro.stps.gob.mx/trabajoseguro/boletines%20anteriores/2015/bol064/vinculos/2005-0786.htm

STPS (2013). Información sobre accidentes y enfermedades del trabajo nacional 2004 - 2013. D.F. STPS.

Vergara, J., Fontalvo, T., y Maza, F. (2010). La planeación por escenarios: Revisión de conceptos y propuestas metodológicas. Prospect, 21-29.

Villaseñor, J. (2013). Obervations from above: Unmanned Aircraft Systems and Privacy. Harvard Journal of Law & Public Policy, 36, 457-517.

Watts, A., Ambrosia, V., & Hinkley, E. (2012). Unmanned Aircraft Systems in Remote Sensing and Scientific Research: Classification and Considerations of Use. Remote Sensing, 1671-1692.