Accident Prevention through Installing a Quality Human Factors Program in a Work Organization

Author

Shakil Ahmed Siddiqui, MCIT (UK)
8/1, Hashim Raza Road, Model Colony
Karachi - Pakistan
E-mail: instructoraerospace@yahoo.com
ACCIDENT PREVENTION THROUGH INSTALLING A QUALITY HUMAN FACTORS PROGRAM IN A WORK ORGANIZATION

by

Shakil Ahmed Siddiqui
Karachi - Pakistan

OPENING VIGNETTE

This paper focuses on human factors aspect of accidents in Customer Oriented work organizations ranging in a continuum of service to manufacturing and all in between. Paper manifests a proposed Human Factors Error Management program, MERA (Managing Error Related Activities). Installing such a program in a work environment will assist in acquiring an active whistle blower by continuously monitoring the processes and activities of the system. The human beings are the center of all activities and interactions in every industry and in a broader spectrum of Customer relatedness in modern organization; their utmost importance and involvement in doing good and not good can’t be ignored. To err is human and it’s not reasonable to expect error free human performance. Errors, that can lead to problems of accident and incident and in either case, the customers have to suffer, Customers; the focus of all organizational processes. The paper will throw light on Human Factors, define the concept of Error Management, Discuss the Accident Causation Model, show the cost of human errors, relate the Quality Management tools to Error Management System, and unveil the proposed comprehensive Human Factors Error Management program MERA. Surely, we can’t do a day without Customers, but can we dare try doing with customers without the safety.

HUMAN FACTORS-A FACT OR FANATASY

Consider the Chernobyl disaster, Three Miles Island, Collision of two B747 aircraft at Teneriffe airport, mid air aircraft collision over Zagreb, Exxon Valdez Oil spillage, countless fatal road accidents, what is common in all these tragic accidents that caused loss of precious human lives and capital? The single dominant element identified behind these tragedies being HUMAN FACTORS. Today with the advent of automation, computerized process control, Quality measures, advancement in metallurgy, technological progress, proceduralization, optimized system performance level etc. When some accident happens it shakes our complacency and a big question mark appears to “Why” with all these sophisticated instruments of control in place, such thing can happen. In past 40 years, over 80% of accidents and incidents were related to the human element and were largely preventable through the proper application of Human Factors principles.

<table>
<thead>
<tr>
<th>Human error estimates System</th>
<th>% due Human Errors</th>
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<tbody>
<tr>
<td>AIRLINES</td>
<td>70-80</td>
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<tr>
<td>SHIPS</td>
<td>90</td>
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<tr>
<td>PROCESS CONTROL</td>
<td>80</td>
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<td>NUCLEAR POWER (US)</td>
<td>70</td>
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<tr>
<td>ROAD TRANSPORTATION</td>
<td>85</td>
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<tr>
<td>AIR TRAFFIC CONTROL</td>
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The following graph is a telling illustration of the single dominant factor about these occurrences incorporating humans as the causative force for accidents. The saying that "to err is human" has a sound scientific basis. Studies have shown that the proportion of accidents caused by human error in majority of the accidents is in the 60-80% range, not including design errors.

**HUMAN FACTORS-AN INSIGHT**

Human Factors, also known as ergonomics, is the scientific study of how a person interacts with his or her surroundings, as well as the effects of those surroundings on the person. Human Factors refers to the study of human capabilities and limitations in the workplace. Human Factors include, but are not limited to, such attributes as human physiology, psychology, work place design, environmental conditions, human-machine interface, and more. Human Factors researchers study system performance. Human Factors involves the overall performance of human beings within a system; it seeks to optimize people's performance through the systematic application of the human sciences, often integrated within the framework of system engineering. Its twin objectives can be seen as safety and efficiency. Human Factors is the interaction of humans with four elements of a work organization that is Man, Management, Machine and Milieu (environment).

Human factors is targeted toward the people: the internal and external customers. Human Factors focuses on human interaction with technology. The knowledge that is gained through research is applied to the design of tasks and equipment. The goal is to make it easier and safer for people to use machines, everything from a simple hammer, to complex instruments. An in-depth investigation of accidents and incidents has revealed that a series of human errors (known as a chain of events) was allowed to form until the accident occurred. If we can break the chain...
events at a certain level, the accident will not likely to happen or with lesser consequences. Furthermore, there could have been safety nets (measures) put in place to prevent this incident from even happening. The safety and effectiveness of an organization are directly related to the performance of the people who are involved in activities of varied magnitude and foci. Contemporary Human Factors encompasses a much wider field of study. In brief, human factors studied the human dynamics and the relationship to work. A broad scope of factors have been involved: work design (i.e., work cards), facility design, work related stresses, environment (weather, lighting), workplace interactions (work team conflicts, departmental divisions) and workplace diversity (female, male, minorities). All these items affected workplace stresses where time constraints of delays; workloads during different operations; and interpersonal conflicts between peers, supervisors, and managers could cause major contributions to error. Human Factors programs helps to improve and enhance teamwork, communication, coordination, performance, stress management, resource utilization, and decision-making.

Gordon Du’pont, a Human Factors specialist identified 12 elements, which either singularly or in combination causes Errors in a work place. They are typically called Dirty Dozen.
1. Lack Of Communication 7. Stress
2. Lack Of Resources 8. Pressure
3. Lack Of Teamwork 9. Norms
4. Lack Of Situational Awareness 10. Distraction
5. Lack Of Assertiveness 11. Complacency
6. Lack Of Knowledge & Decision 12. Fatigue

FOCUS SHIFT TO HUMAN FACTORS

The increasing significance of human error is Prior unique to organizations. In the 1960s, when the problem first began to attract serious attention, the estimated contribution of human error to accidents was around 20%. In the 1990s, this figure has increased fourfold to 80%. There are many possible reasons for this-dramatic increase, but these are more significant:

1. The reliability of mechanical and electronic components has increased markedly over the past thirty years. "People have stayed the same."
2. Due to introduction of better process control and automation, a mismatch of the Liveware- Hardware (L-H), and Liveware' Software (L-S) components of SHEL model.
3. Increased system complexity creates, the potential for organizational accidents in which latent procedural and technical failures combine with operational personnel errors and violations to penetrate or circumvent defenses. In short, complexity acts to shift the errors to other people.

A TYPICAL HUMAN FACTORS PARADIGM

To clarify human factors into a manageable approach, practitioners commonly used the SHEL model as a classification strategy. SHEL stands for Software, Hardware, Environment, and Liveware. Software would embody rules (ISO, MBNQA regulations, company requirements), policies, procedures, customs or norms, and perceived expectations (management and worker perceptions may be completely dissimilar). Items included in hardware may be buildings, vehicles, equipment, tools, and aircraft. Environment covers not only physical attributes but also the political and organizational structures that workers must deal with on a daily basis. Included would be the economic framework upon which workers must make decisions. Most importantly, live-ware deals with the people or humanist factors that effect worker performance.
HUMAN ERROR CLASSIFICATION

It has been evident for most of recorded history that people are prone to commit errors ("To err is human..."). Our own common experience indicates that we all commit many errors each day. Error may be defined as the failure of planned actions to achieve their desired goal. Errors can originate in any of the three processes of Perception, Decision Making and Action.

Human error are as the unintended actions that cause system discrepancy. Other authors have defined human error as any action that is out of acceptable limits, where "acceptable limits" are defined by the system. Traditionally, quality lapses, unsafe acts and Less Than Adequate (LTA) performance are sorted according to their adverse impact upon the system. These error types fall into two general classes:

a) The introduction of a discrepancy that was not there before the maintenance activity began.

b) The failure to detect damage or discrepancy during maintenance or inspection.

Three distinctions have proved useful in identifying the various origins of LTA performance. Such distinctions are important because different types of human failure have different psychological origins, occur in different parts of the system, and require different methods of remediation.

SLIPS

The plan of action may be perfectly adequate, but the actions do not go as planned. That is, we planned to do the right thing, but something happened that prevented us from doing it properly.
Some necessary act(s) may be omitted or an unwanted act(s) may intrude. Alternatively, the right actions can be carried out, but in the wrong order, or in relation to the wrong objects, or poorly timed, or clumsily executed. These are execution failures and are commonly termed slips, lapses, trips, or fumbles. The problem may occur at one or more of the three processes in the general model shown. Slips and lapses occur during the execution of routine, well-practiced tasks in familiar surroundings in which the individual actions are controlled in a largely automatic fashion. In other words, these execution failures typically occur at the skill- or rule-based level of performance.

Skill-based slips. The skill-based (SB) level of performance is related to actions that have been done many times, typically on a daily basis over a period of many years.

Rule-based slips. The rule-based (RB) level of performance is characterized by tasks for which training, experience or procedures have provided ready-made solutions or "rules." Rule-based slips are typically the result of failing to properly follow the rules that have been established.

MISTAKES

The second potential locus of error is in the planning itself. The actions may go entirely as planned, but the plan itself is not adequate to achieve its intended outcome. These are higher-level failures, termed mistakes, associated with the formulation of the plan. Mistakes can be further sub-divided into two classes, according to the level of performance at which they occur.

Rule-based mistakes. RB mistakes involve failures in the selection or application of these problem-solving rules.

Knowledge-based mistakes. The knowledge-based (KB) level of performance is characterized by the need to solve novel problems for which the individual possesses no pre-packaged "rules," and is thus required to work out a solution from first principles.

FAILURES

We call the serious consequences of human errors "failures." Some human errors have serious consequences. A great percentage of human errors can cause or contribute to safety lapses or, in severe cases, accidents that destroy property or injure people.

Active failures are the result of unsafe acts (errors and violations) committed by those at the "sharp end" of the system (machine operators, pilots, air traffic controllers, etc.). They are the people at the human-system interface whose actions can, and sometime do, have immediate adverse consequences.

Latent failures are created as the result of decisions, taken at the higher echelons of the organization. Their damaging consequences may lie dormant for a long time, only becoming evident when they combine with local triggering factors (e.g., errors, violations and local conditions) to breach the system's defenses.
ACCIDENT CAUSATION

E
ey industry today is a complex productive system. The human beings are present there as basic elements of system as decision-makers, line management, and production activists. The Reason’s, model of accident causation shows how human contribute to the break down of the complex, interactive and well guarded systems, to produce an Accident. Because of technological advancements and excellent In-work defenses, errors result from a series of failures already present in the system. The iceberg analogy depicts that only the operationally significant errors catch our attention and thousand of unsafe acts are lying dormant waiting for a window of opportunity to open and show their consequences. The resulting errors are either (1) Latent, or (2) Active. In a well-guarded system, latent and active failures will interact, but they will not breach the defense. When the defenses work, the result is an incident and when they fail the result is an accident. So humans, by virtue of their nature will make error and it’s unreasonable and illogical to expect error free performances from them. What an Error Management system can do is to lessen the consequences of these errors, which affect the Customers inside and outside. The technological advances of the last 20 years, particularly in regard to engineered safety features, have made many hazardous systems largely immune to single failures, either human or mechanical. In order to breach the "defenses-in-depth," it now requires the unlikely combination of several contributing factors, each necessary but none sufficient to cause the accident by itself. The local factors (dealing with immediate area of work) that may contribute towards errors is an unending list but few most common are listed below:

1. Paperwork, Manuals and procedures
2. Computers
3. Environment
4. Time of day.
5. Pressure
6. Fatigue
7. Support Tools
8. Equipment and parts
9. Morale
10. Knowledge, skills and experience
11. Safety features
12. Inconvenience
The following eight organizational factors are selected as being the most influential.

1. Organizational structure
2. People management
3. Provision and quality of tools and equipment
4. Training and selection
5. Commercial and operational pressures
6. Planning and scheduling
7. Maintenance of buildings and equipment
8. Communication

The anatomy of an "organizational accident" is shown in figure below. The direction of occurrence is from left to right.
The human behavior is the greatest contributor to system failure. The system breakdowns result from combinations of active failures and latent failures, sometimes in conjunction with unusual environmental forces. Active failures are the events, which immediately precede the breakdown. Unsafe acts such as errors or violations are the most commonly identified active failures.

The accident sequence begins with the negative consequences of organizational processes (i.e., decisions concerned with planning, scheduling, forecasting, designing, specifying, communicating, regulating, maintaining, etc.) The latent failures are transmitted along various organizational and departmental pathways to the workplace (the maintenance line, the workshop, the ramp, etc.) where they create the local conditions that promote the commission of errors and violations. Many unsafe acts are likely to be committed, but very few of them will penetrate the defenses to produce damaging outcomes. The fact that engineered safety features, standards, controls, procedures and the like can be deficient due to latent as well as active failures is shown by the arrow connecting organizational processes directly to defenses.

The model presents the people at the sharp end, as the inheritors rather than as the instigators of an accident sequence. Here, attributing blame, though often emotionally satisfying, hardly ever translates to effective counter-measures. The crux of the matter is this: We cannot avoid creating latent failures; we can only strive to make their adverse consequences visible before they combine with local triggers to breach the system's defenses.
SWISS Cheese Model Of Accident Causation

The model of system breakdown proposed by J Reason has become an industry standard framework for analyzing accidents in industrial and transport settings. The model has been advocated for accident investigation purposes by several regulatory and research agencies. The model has been successfully applied to the analysis of accidents in various settings, including nuclear power plants, chemical plants and transport fields.

COST OF HUMAN FACTORS RELATED OCCURRENCES

It is very difficult to gather data and statistics of the occurrences related to errors committed due to Human Factors in different organizations. However, exceptional work and research has been carried out in aviation and space sciences in Human Factors and related fields. We would see certain cost factors related to Human Factors events in Aviation. Commercial Aviation is considered as the safest means of travel as compared to other modes of transportation. However, any accident that happens anywhere in the world attracts global coverage and brings extra caution and whims to the flying public.

1. The average cost of an in-flight engine shutdown is $500,000.
2. The average cost of a flight cancellation is $50,000.
3. The average cost of a return to gate is $15,000.
4. The average ground damage incident costs $70,000.

Scanning the statistics quoted above, if one see the greatest amount of cost incurred is when an aircraft engine is shut down during flight i.e. half a million dollars. To the surprise of all if we look at most important contributing factors for this heavy loss, we are startled by the fact that it’s
not any complex system, sophisticated component or material failure, its nothing but the Human Factors behind this. The top causes of in-flight shut down are as follows:

1. Incomplete installation .................. 33%
2. Damage on installation .................... 14.5%
3. Improper installation ..................... 11%
4. Equipment not installed or missing .... 11%
5. Foreign object damage ..................... 6.5%
6. Improper troubleshooting, insp., test ... 6%
7. Equipment not activated or deactivated ... 4%

**HUMAN-ERROR-MANAGEMENT-SYSTEM-(SMS)**

Human errors are ubiquitous and that the conditions that promote and allow human error are always present. Managing errors requires that we do all we can to prevent them from occurring and to minimize their consequences when they do occur. **EMS is a system or process to collect, analyze, track, trend, and organize information regarding human errors or mishaps.** This includes

1. Error reduction: Measures designed to limit the occurrences of errors
2. Error containment: Measures designed to limit the adverse consequences of those errors that still occur

**EMS --A POWERFUL TOOL FOR CUSTOMER SATISFACTION**

EMS is indistinguishable from quality management. Organizations should employ a wide range of error-reducing and error-containing techniques to create a safe, ubiquitous and conducive culture for their internal customer but also to provide quality, confident services to external customers. One can very easily imagine how an aircraft crash shakes the confidence of million of travel for long time to come. Installing a program that captures errors before they are committed or reduce the consequences of incidents is the basic design criteria of such a program. The success of such a program satisfies the essence of quality management that is right of a customer for safe product and services. Six-sigma, lean manufacturing and like concepts are mostly interacting in highly sophisticated and automated industries. But the real problem still lies with the human element of work organization. Without addressing their performance shaping factors (PSF) that affects their mindset, performance, thinking, attitude, work habits, decision making etc. it is not possible to create a pervasive safe and reliable environment for any kind of customer.
QUALITY TECHNIQUES FOR HUMAN ERROR MANAGEMENT

The committance of errors is governed by local and organizational factors such as human psychology, team building, decision making, knowledge, organizational behavior, environment, stress, fatigue, pressure, software, procedures etc. the following quality techniques can prove beneficial if employed for Error Management System (EMS)

1. Quality monitoring and auditing
2. Procedures, rules and regulations
3. Total Quality Management (TQM)
4. Training and retraining
5. Human resource management
6. Anonymous Reporting
7. Critical Incident Technique
8. Error Environment Assessment
9. Fault Tree Analysis
10. Failure Modes and Effects Analysis
11. Pareto Analysis

Application of the above techniques and tools is not new to the Quality personnel and their induction in managing human errors and Human Factors discipline has proven success record. I would only discuss in brief Critical Incident Technique in relation to Accident Prevention and Human Factors error management system.

CRITICAL INCIDENT TECHNIQUE

The idea behind this method is that failures don't usually occur spontaneously. Rather, for each failure that is committed there are many "critical incidents" that set the stage for failures. A critical incident is any situation in which errors almost cause a failure or in which a failure is in progress, but something or somebody prevents it from going to conclusion. The Critical Incident Technique is one of many anonymous reporting methods. It typically relies on some form of anonymous survey to solicit information from workers. Also, the method works best when it is a continuing program, rather than a one-time solicitation.

MANAGING ERROR RELATED ACTIVITIES (MERA)

The safe and continued operation of any product or services is of prime importance along with many other parameters of outcome of any organization. Just like “the cost of poor quality” the cost of poor safety has its own impacts on the overall scenario of competitive advantage, core competency, customer retention and loyalty. Its not just in the businesses that have global playing field but also locally operating small organizations where any safety related occurrence shakes the tranquility of the internal and external customer and insecurity emerges as a big question mark like who next, what next and when again? To provide one answer to quality safety related issues a Program relating to Error Management is introduced here. The program MERA provides a launching pad for any organization, which rates the safety and related issues as important as other indicators of profitability, customer focus, competitiveness and quality. If we can’t continue without Customer, think of doing it with customer but without safety.
WHAT IS --*(MERA)*

MERA (an acronym for Managing Error Related Activities) is a set of diagnostic and management tools. MERA provides a foundation for initiating and installing a Human Error Management program in a work organization. The activities under MERA encompasses a variety of functions depending upon the severity of problem and intent of management. MERA is proactive. It seeks to identify local and organizational problems before they combine to cause an accident or incident. Quality and safety, like health and happiness, have two aspects: a negative one revealed by quality lapse reports, incidents, and accidents, and a positive one having to do with the system's intrinsic resistance to human factors problems. Whereas the former convert easily into numbers, trends, and targets, the latter is much harder to pin down and measure. MERA is a set of diagnostic tools for making visible, within a particular work location, the situational and organizational factors most likely to contribute to human factors problems (and, indirectly, human error). If designed carefully and applied properly, these measures give an indication of the system's state of safety and quality.

According to MERA, accident producing factors in the workplace fall into three basic groups: Human Fallibility, Technical and Procedural Shortcomings, and Local Hazards.

The contents of each of these buckets can vary from time to time, but they will never be completely empty. Imagine that each bucket gives off particles. The fuller the bucket, the more it gives off. Let us also assume that accidents and incidents arise when these various particles combine by chance in the presence of some weak or absent defense. MERA is designed to give an up-to-date indication of the fullness of the buckets. MERA is exclusively operational only if a human factors issue is identified behind an event and caters for the typical organizational and local issues in consideration. Any incident or accident that is outside the scope of Human Factors aspect of happening is not addressed in MERA. A typical Human Factors accident prevention MERA Program takes the following shape
Four components of MERA are:

1. Human Factors Training
2. Error Management Strategies
3. Human Error Management
4. Human Error Investigation

**BREAKDOWN OF MERA**

1. **HUMAN FACTORS TRAINING**
   - Human Factors awareness programs
   - Initial training
   - Auditors/ Investigators’ training
   - Level I to Level III training for line personnel
   - Any regulatory or other related HF training and Recurrent programs
2. **ERROR MANAGEMENT STRATEGIES**

- MERA formulation
- MERA implementation
- Liaison between Man, Management and Mission
- Reporting system
- Awareness activities
- Publications

3. **HUMAN ERROR MANAGEMENT**

- Data collection & analysis
- Trend monitoring
- Cost Implications
- Error Capturing
- Occurrence Reporting System

4. **HUMAN ERROR INVESTIGATION**

- MERA
- Through auditors
- Confidential Interviews
- Volunteers
- Others

The whole program may be recapitulated in four words, Dedication, Design, Deployment and determine the Feedback.

**THE MERITS OF INSTALLING MERA**

1. MERA is proactive and seek to identify the contributors before they combine to cause a problem.
2. MERA is cost effective and doesn’t need any sophisticated tool, equipment or software. This can be installed as part of worker teams or quality circle.
3. MERA can be installed wholly or partially, keeping in view the severity of problem and prior usage of any such program.
4. MERA is ongoing and self-sustainable once it is transferred to its users.
5. MERA is an effective management information system for capturing and arresting human errors using designed techniques, collecting data, analyzing trends and creating safety nets.
6. MERA is intended to find root causes discarding blame cycle and focusing on the Fault not the Fellow.
7. MERA is harmless for employees and may run silently in the background.
8. MERA helps to achieve a cultural breakthrough in terms of enhanced safety for the customers inside and outside.
9. MERA aids to devise and establish safety culture in organization.
10. MERA effectively reduces or helps to reduce the “cost of poor Safety”.
CONCLUSION

Human Factors today is recognized as the single major cause behind many accidents. These occurrences not only wipe away hard-earned profit but also create an uncertainty in smooth functioning of organizations. Human Factors issues, nevertheless is present in all modern organizations, without addressing which, it’s not possible to achieve a quality safety system to the satisfaction of the customers within and outside. All Human Factors training and implementing programs are targeted toward specific organizational and local factors in a company. It’s not a Quick fix or One Solution for all. Organizations have to commit themselves to the importance of addressing Human Factors related issues and devise such programs that address these issues in totality. Human Factors programs helps to improve and enhance teamwork, communication, coordination, performance, stress management, resource utilization, decision-making etc. If specifically tailored solutions are to be designed keeping in view the specific need of the organization. Remember, MERA is there to help you! MERA is a set of management and diagnostic tool that can be installed in any organization to help achieve a safe pervasive safety culture. The four components of MERA encompass Training, Strategy, Management and Investigation.

AUTHOR’S SYNOPSIS

Shakil A Siddiqui, holds a Master Degree in Administration Sciences from Karachi University. He has also acquired two Post Graduate Diplomas in Public Administration and in Transport respectively. He has Airline operations' experience of more than 18 years to his credit. He is a qualified Aircraft Maintenance Engineer on Boeing B747,B737,and Airbus Aircraft. He is a qualified Human Factors Facilitator and Human Error Investigator from Boeing, USA. In 2001,He has participated in a Human Factors Research Program conducted by Air Transport Group of Cranefield University, UK. He has conducted presentations/lectures on Human Factors at forums like JICA (Japan), RAES-CILT(UK), BOEING,(USA) and Karachi University. He is a regular speaker on Management and Organizational Behavior on different forums, seminars and at reputed Business Institutions. He is a Member of International Aviation Psychologist Association, and,Chartered Institute of Transport, UK. He has been instrumental in designing and installing the Human Error and Accident Prevention Safety Training programs. He is currently enrolled in 5th batch of CQP course organized by PIQC.

MAY ALLAH BLESS US ALL

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