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The Impact of Automation on Human Behavior-A Review

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ABSTRACT

The intelligence is the prime determinant on which humans are both distinguished and considerably unique among all the creatures in this universe. With the advent of the field of Artificial Intelligence, the era of automation has revolutionized the human life. The AI may well be a modeling of the human intelligence. For humans are, to a first approximation, intelligent; they can perceive, act, learn, reason, and communicate successfully despite the enormous complexity of the tasks. Since humans react differently to the functioning of different automated systems, it is imperative to understand, what the impact of automation on human machine interaction is. The interaction between humans and fully automated facilities or machines is a key issue for the researchers in the field of Psychology, Robotics and Ergonomics. This paper focuses on few important aspects the automated systems on human behaviour in different settings and examines the effects produced by them. This study is an evaluation of the effects of automation on the human behavior and to elucidate on both positive and negative impacts of automation on human behavior.

Keywords: Artificial Intelligence, Automation, human-robot interaction, human behavior, robots

I.INTRODUCTION

The technological revolution powered by Artificial Intelligence (AI) has metamorphosed the human life and workforce in the current century. John McCarthy [1] initiated the research on AI and argued that Intelligence and its domains can be simplified precisely so that they can be simulated by a machine. In this context the AI is on one hand defined as the field which investigates the intelligent problem solving behaviours and creating intelligent computer systems. On the other hand Automation means actually solutions to problems, higher production volumes, increased profits, lower costs, economical benefits for companies and recognition on the global markets. It's made concrete by going forward in all actions that organizations all around the world perform to challenge themselves for a better future. Human everyday tasks are already simplified by the technology which is fast growing thus prompts the behavior scientists to probe into the human factors arising out of human-machine interaction. The present paper focuses on few important aspects regarding the interaction between humans and fully automated systems in different settings and examines the effects produced by them. This study is an evaluative study which intends to review the research on the effects of automation on the human behavior and to elucidate on both positive and negative impacts of automation on human behavior. Computers, algorithms and softwares simplify almost all the everyday tasks and we can hardly find our day to day activities without the intervention of this computer assisted automation systems. AI has also fundamentally revolutionized the global industrial and labour market with the exponential growth resulting into a huge scare of losing human

workforce and replacing them by machines. The future seems uncertain due to the impact of AI on changing the work environment, working time, remuneration, possible threats to employment and subsequent pervasive social impact viz, mass unemployment, mass poverty and other social distortions.

Developing new technologies through implication and interest, in the direction of sustainability, implicate higher power of creativity, flexibility, resistance, even awareness of existing and ongoing risks [2]. Automation has been playing a significantly crucial role in our lives since the beginning of 1940s, when companies started to generate new ideas for their production lines, implement shortcuts in the production systems, applying low-cost alternatives and trying to work as efficient as possible to fulfill customer needs on a larger scale. In fact the craving for automation is not new; it is the outcome of human curiosity since the dawn of human civilization on earth. People have been trying to find better ways of doing jobs, based on technology. When talking about "automation", robots, computers, production lines, airplanes, trains, futuristic infrastructures, cross our minds. It intends to make human lives and daily work easier.

The effect of automation on the human behavior needs to be treated in detail, in order to offer the expected values for a better understanding of the new technologies. The area which deals with the human machine interaction or using the technology in a simplistic and most productive manner is named as Ergonomics which is not only a part of engineering psychology but an individual sub field. Human Factors and Ergonomics (HF&E) as it is popularly called intends to understand the interaction and other systems and tries to use the accumulated theories, principles and best possible methods to optimize human well being and system performance. It also tries to answer the fundamental question, why the automation is important and how is it going to affect the mentalities of humans, beings, both workers and consumers? With the introduction of the automation in last three decades, the insecurity among the workers concerning their future has increased. It is argued that the AI, Automation and Robotics do not pose a possible threat to human employment but enrich the human workforce [3]. The result of automation has enriched the production methods, employees are either used for another tasks, or encouraged to enrich their practical and theoretical backgrounds by taking over new tasks and following training periods within the companies. This extends Bainbridge's [4] view that humans, due to automation, increasingly take on new tasks such as those related to system improvement. Likewise, Autor [5] rhetorically asks why we still have so many jobs after decades of automation, and suggests that productivity-improvements in parts of a production process often serve to increase the value of the remaining parts, increasing the value of human skill and knowledge. Most of the companies provide specialized trainings on a long term, for incorporation both their human workers and the robots they invested in. Through that, the companies are able to grow their own employees in the way that their abilities can be used to reach the expected amount of production capacity and progress in their business. One of the biggest impediments to the automation is tech-aversion among some employees who manifest their resistance to such changes as a result of their perception of incapability to handling such tech-driven changes. But given the magnitude of the automation in the current world order, there is no way out for such employees to resist change because automation is the all pervasive inevitable world scenario for the future of the human living and workforce.

The solution to tech-aversion, and other human factors in tech based organizations of current times Ergonomics. Ergonomic factors include such things as environment (noise, layout, temperature), hardware (furniture and

video display terminal equipment), and software (user system interfaces, training, and documentation). Two areas of ergonomics have been discussed by most researchers. They are the design of office space and the design of office furniture. Both have had an impact on how work is done. Researchers have long back argued that the office and other work settings should be managed in a people friendly manner [6]. Maas further argues that peoples' hostility towards computer based systems and automation will decrease with the passage of time as more and more people will be able to attain the automation skills through training and experience. The factors in physical settings include interactional distance -- how close or far people should be to each other, adjacencies -- who should be physically next to whom, lighting, and human-computer interaction (HCI) are the major issues when we review the impact of automation on human behavior. Stone and Luchetti [7] also focused on the physical design of the office environment and argued it highly important. Stress is inevitable in an automated system which can be minimized by ergonomics at automated workplaces [8]. The reactions to the office stress can be classified into four groups that are interrelated, these groups are: Physical symptoms like visual and postural discomfort, headaches and nausea. Psychological symptoms such as low self-esteem, negative attitudes towards computers, fear of the future, and depression. Motivational symptoms include low motivation, boredom, fatigue, and feelings of loss of control and the Behavioral symptoms are incomplete work, communications problems, and changes in work output. Stressors, come from an office environment which is inhospitable or unrewarding. Some of the major office stressors are: poorly designed office equipment (video display terminals, furniture and lighting), work ambiguity, demand for increased work productivity, and uncertainty concerning career goals. Office ergonomics, Cirillo points out, is a way to help solve these problems because the concept is to design computer systems to the human being. Koffler [9] also stresses the importance of incorporating ergonomic design into the entire design process when dealing with computer technology and the automated office. Ergonomic design contains issues that include not only hardware and software but also issues such as training and documentation. Theil [10] also supported the ergonomics and its importance on work performance and human psychological stability. On the other hand office and furniture ergonomics, Diebold [11] says, is becoming obsolete as the interaction of humans and computers changes. He believes ergonomist must be concerned with the future of automation and not dwell so much on the present. Ellis [12] reviews research that had been conducted on organizations whose organizational structure has been affected by information technology. These changes, the author says, have affected space planning requirements, and the implications for planning and design. He provides some insight on future designs of office buildings where new information systems will be implemented. The first is the organizational size, which will change with advanced information technology organizations will become smaller or be sub-divided into smaller independent entities. Offices and buildings will have to adapt to these changes in which more than one organization may occupy a building. Adaptability is the key. Second, the workgroup size -- will become smaller, thus lessening the need for open-plan areas. This will in turn lead to changes in the physical layout of offices. Third is the forms of interaction -- will be different. There will be a need for communal areas with less emphasis on individual offices. Office spaces will become smaller as more room is used for conferencing areas. The fourth and the final according to Ellis [12] the need will increase for buildings suitable for multi-occupation and highly flexible servicing for smaller organizations within the same building. Such changes in the physical and work settings

have already been witnessed but the people are getting adapted to such changes steadily. These adaptations are quicker in the countries which had early exposure to the automation and the fourth industrial revolution which it is popularly called.

II.EMOTIONS AND HUMAN-MACHINE INTERACTION

The human machine interaction is a complex phenomenon which entails a vast body of research based knowledge generated by the researchers in many contexts. One such context is the human-like emotions incorporations in a machine so as to make interaction more efficient and meaningful. The human affect has an important relationship with trust [13]. Since people sometimes treat machines as humans, there is an obvious role of affect in trust related to automation, in particular when they treat autonomous machines as people [14]. A conversational agent trained to elicit and express affect, although obviously not human, gains more trust through this training, even though participants do not believe the machine itself is experiencing emotion [15]. It is possible affect may cause us to overly trust the machine. In some situations, it appears it is better not to let a machine pretend it is a person. Kiesler et al., [16] showed that, in a prisoner's dilemma, people generally played fairly with a computer – but that a text interface worked better than a semi-human one. A text interface may make it easier to overlook the human/computer difference. Such a result has interesting implications – in situations in which a machine is being compared to a human, it may be that the medium through which the message is delivered will be significant.

III.PERSONALITY AND HUMAN-MACHINE INTERACTION

The human-machine interaction involves the personality factors of humans and possible programmed traits in machines working for automation tasks. The traits like Openness, Agreeableness and Conscientiousness as individual differences may play a role in the behavior of subjects interacting with a machine-human team. Conscientiousness, for example, has been associated with the tendency to be cautious and avoid mistakes. It may be that highly conscientious individuals will be more likely to follow instructions under conditions of uncertainty and risk than individuals who are low on the same trait [17]. Openness has been studied in the context of new product development teams and decision making teams [18]. In this study, the investigators found that openness moderated the effectiveness of computer assisted decision making. More open individuals made better decisions under conditions of computer mediated communication. Moreover there is evidence of stress changes decision making and in particular the decision making of pilots [19, 20]. As a generalization, decision making is worse under conditions of time pressure. Some studies show that the choice to use automation is influenced by our own self-confidence in a situation – the less self-confidence; the more likely we are to choose automation.

IV.EMPLOYEE MONITORING SYSTEMS AND HEALTH RELATED ISSUES DUE TO AUTOMATION

One of the important outcomes of the automation is the computer based monitoring system. Earlier only clerical staff was monitored but now all the work divisions of the organizations are monitored. The use of computers for e-mail, calendars, and project tracking by managers and supervisors has made it easier for their work performance to be monitored as well. It is expected that stress related illnesses will increase at these positions also. The neck strain is a commonest form of computer related health issue in current times. According to Bloom [21], *"computer related illnesses are not only related to the computer equipment but also are due to the surrounding environment and the stresses caused by that environment"*. Reynolds [22] also emphasized the health issues related to computer usage. The most widespread of these are video-display terminal illnesses, which include eye strain, repetitive motion injuries and back strain.

V.AUTOMATION AND HUMAN PERFORMANCE

Considerable number of studies is available to highlight the automation and human performance outcomes. Automation has both beneficial and negative effects on human performance [23]. The results of this study were also supported by Sarter et al. [24]. The automation technology is having the severe operational challenges unless it is not learned properly before handling or operating. The difficulty in handling and operation of the gadgets used in automation technology increases the cognitive and physical workload of the operator which results into an unwanted work stress [25]. The term used for such a system is 'clumsy automation' which is actually the opposite of what is expected of automation [26]. When the use of automation technology instead of reducing workload, increases it, the resulting state is counterproductive for the worker or the operator. In fact use of high level of automated technology may render an operator clueless in case of a technical snag. In such a case of non-reliability of automation in decision choices, the operator may not be able to monitor or even detect the automation malfunctions. This phenomenon is known as automation-induced complacency [27, 28]. On the other hand when the reliability of the automated system was relatively high and unchanging, the operator monitoring of the automated system was poor compared to manual control condition [28]. In an interesting study by Tiwari et al. [29], it was argued that "complacency might reflect an "attitude towards automation". Moreover, the complacency effect was eliminated when the reliability of the automation was variable, alternating between high and low, or when the automated task was the only task. Parasuraman et al. [28] attributed the poor monitoring to an attentional strategy related to operator overtrust of the automation [30]. Human performance problems in automated systems also is a result of key underlying factor in complex, automated systems control, that is human out-of-the-loop (OOTL) performance. Out of the loop performance (OOTL) problems are characterized by a decreased ability of the human operator to intervene in system control loops and assume manual control when needed in overseeing automated systems. First, human operators acting as monitors have problems in detecting system errors and performing tasks manually in the event of automation failures [31, 32, 33]. In a review of automation problems, Billings [32]noted six major aircraft accidents that

could be traced directly to failures in monitoring automated systems or the flight parameters controlled by the automated systems.

To overcome some of the ills created by technology-centered approaches to automation a philosophy of human-centered automation has been proposed [34]. He defined human-centered automation as facilitating a cooperative relationship in the control and management of a complex system with potential benefits for performance. Human-centered automation has many alternative meanings ranging from 'allocate to the human the tasks best suited to the human, to the tasks fully performed through an automated system [35]. The hierarchical models of Levels Of Automation (LOA) proposed by Endsley [36] which ranged from manual control to full automation or the models of Ntuen and Park [37], Sheridan and Verplank's [38] or that of Endsley and Kaber [39, 40] 10-level taxonomy of LOA had four common functions, i-e monitoring, generating, selecting and implementing the tasks. These models emphasized the selective allocation of tasks to human and automated systems.

In comparison to LOA approach, the Adaptive Automation (AA) emphasizes on the varying degrees of computer assistance in complex system controlled based on the nature of the situation including task characteristics [41]. Rouse [42] also identified several advantages of AA including support of human performance, dynamic definition of a coherent task role for operators and the capability to maintain acceptable human workload levels in system control. Some authors opined that under AA, different types of automation may be initiated and terminated dynamically based on situational demands placed on the system, inclusive of the operator [43, 44]. The key difference between the AA and LOA approaches is that AA involves dynamic control allocations (automated or manual, varying over time) and LOA involves static function assignments defining the degree to which a task is automated [45, 46].

VI.AUTOMATION AND STRESS

Stress is one of the most widely researched areas of the 20th century. Stress is a reaction and appraisal to the incoming stressors from the environment. It is regarded as a transaction between people and the environment and described in terms of 'person–environment fit' [47]. Stress is central to the automation or computer-aided technology and the human behavior. Many researchers have studied this context: For example, Matthews and Desmond, [48] posited that within the context of automated systems, stress tends to have three effects: it overloads attentional capacity, disrupts executive control over selective attention, and disrupts adaptive mobilization of effort. These findings are also supported by the researches on driving behavior under increased attentional workload and on effects of stress on pilot decision making [49, 50].

Stress has been studied by some cognitive psychologists differently in last few decades of previous century with emphasis on emotional and motivational factors like intense noise, feedback, electric shock, sleep deprivation, mental workload, and personality factors [51-59]. Moreover it is also argued that the automation has rendered humans sitting down and overcome the monotony of semi-automated or manual handling of works which has a direct bearing on stress [60]. Automation result into stress due to monotony of machine handling or changes in the routine work due to automation or individual's inability to adapt to the changes [61]. Interestingly a

reduction in the numbers of operatives and line workers per unit area could impact on emotional well-being as a result of isolation and solitude experienced by many workers in the industrial workplace. 'work activities give man a part of his very identity', warning that 'a threat to his own individual contribution can prove extremely disturbing' [61]. Automation reduces employee stress by less supervision and micromanagement and reduction in risk of human errors takes pressure off the workers. In this way automation may contribute to occupational stress and may also overcome workplace stress depending on other psychological and situational factors.

VIII.AUTOMATION AND CREATIVITY

The widespread automation prevents human participation in a process of a task or a product which compromises human creativity. Automation has already tightened the realization of human potential in complex systems. Frey and Osborne [62] found that creativity is a key bottleneck to computerization: the skills required to innovate are not readily replaceable by a machine. It is true that many creative occupations have undoubtedly been affected by computers, for instance in Kashmir the worst hit area is handicrafts. The computer–controlled equipment is unlikely to substitute for labour in creative domains. Instead, computers serve as a complement to most creative professions, making creative skills more productive. Additionally the key finding that creative occupations are much more resistant to automation should not be surprising when one considers that computers will most successfully be able to emulate human labour when a problem is well specified – that is, when performance can be straightforwardly quantified and therefore evaluated [63].

Since creativity involves interaction with the environment, it is only possible in flexible settings with Adaptive Automation (AA). Creativity and innovation coupled with technology helps in better design, equipment, methods or different systems that conserve resources, minimizing the environmental impact, increase the human safety and protect the natural environment. The basic purpose of automation is efficiency, reliability precision with higher accuracy than the human worker itself. Creativity and innovation in new technology reflects developing new alternative systems of production with different and new parameters, with close collaboration of humans and machines within the production system. This objective is impossible by fully automating the process and systems. The replacement of machines does not threaten the job of humans instead provide new scope for innovation and change [3].

IX.AUTOMATION AND HUMAN BEHAVIOR: SCOPE FOR FUTURE RESEARCH

A robotic device is programmed by humans and is made to work in collaboration with humans. The principle is to re-create a co-worker with greater efficiency and enormous potential. One that will help the human worker to execute tasks which otherwise was impossible for humans to execute or were considered to be way too hard on his body, such as lifting heavy weights or doing repetitive tasks. A virtual infinity of applications can be done by robotic co-workers. Having a robot to work safely alongside humans can improve the production flow; allow the automation of new processes by using the best of robots and the best of humans. Collaborative robots are now designed to work alongside humans without any fencing [64].

In this enormous change in the surroundings due to automation, observing the human reaction to change can provide answers to a multitude of questions. Do customers react to a better quality of products? In most of the cases, the consumers make their decision based on new ways of producing goods, because through this, consumers can define a product such as "the best one" taking into consideration the principle: "better quality at a better price, or excellent quality at reasonable price". In such changing demands, the automated product services become inevitable which reduces the cost and increases the efficiency. Yet the focus is still on the human workforce. Humans are the basic resources that can build an entire production system from zero, capable to add and switch components, replace damaged equipment, who are always aware of errors within an organization. Robots can detect errors, but in the moment, they just can't repair or sustain themselves. Artificial intelligence will not be developed without the "real thinking machines". The researchers on one hand are scared of the fact that the automation systems may render people jobless as it has been argued that the since robots efficiently make precise and fast procedures which is utterly impossible for human workers or can also perform under highly dangerous situations like, duct cleaning, fix oil spills, analysis of hazardous environments or extremely dangerous polluted environments, space exploration or risky drilling operations that can be done exclusively by the robots or other intelligent equipments. Robots and intelligent machines can have not only supporting, but even lifesaving functions. Examples are robots used in medical diagnostics, which have high accuracy, or for the assessment of dangerous objects using remote control and integrated camera systems. These make it possible, for example, to defuse a bomb without a human having to come close to it or to guard the tense borders. On the other hand researchers do believe that automation do not cut jobs but render employees more efficient with greater technological support [65]. The companies still need employees to maintain and supervise the robotic production lines. If employees manifest fear of losing their jobs, it could cause damage to a company, through inside tensions and even intentional damage to existing technology from the work place. This might be one of the concerns at this level, and companies can come up with solutions for the human workers such as job enrichment or job rotation, in order to keep them motivated. An important thing that employees should realize is the fact that automation could generate other vacant positions within their companies [66].

The impact of automation on human behavior could be in a significant number more positive that the negative. In the present times, these digital assistants (robots) are just assistants – helpful when asked to help, and certainly, not freethinking. Is artificial intelligence therefore replacing the human element? Not at all – it is simply taking a laborious task away from an employee who can add more value tackling a more challenging problem [65]. It is highly unlikely that artificial intelligence will ever be able to display the creative and intuitive capabilities needed to match humans at the tasks. The activities are not always clearer and specific as robots need to know in order to work on human behalf. Things are not always black and white, right or wrong. Fundamentally, the service industry is about people solving problems for people. Human issues need human solutions. Robots will only ever be able to support the problem-solving structure. It cannot replace it. Modern technology is considered to be just a tool that needs to be used efficiently in order to gather the maximum amount of value. Therefore technology will dramatically change the nature of our jobs, but it won't take them away. Rather, it will free up individuals to focus on higher value challenges that can only be tackled by a human mind. As Rossi [67] argues that, *"The workforce of the future should need to focus on new ways to apply and*

leverage skills so workers can add greater value. This workforce of the next generation could be defined by jobs that embrace and make sense of data and smart machines. It's all about changing perceptions of not only what is needed but what is most valuable for us to dedicate our lives to". The most important impact the automation may have on humans is on that of worker mentality, and could generate a decrease of self-esteem, felling of not being useful anymore and of course resistance towards new technologies and changes. Still the key words for solving such issue are long term social-economic-environmental sustainability and re-training of workers to provide auxiliary tasks required by these new technologies. But companies still need employees to maintain and supervise the robotic production lines and it's going to be this way until real artificial intelligence is discovered and implemented. If employees manifest fear of losing their jobs, it could cause damage to a company, through inside tensions and even intentional damage to existing technology from the work place. This might be one of the concerns at this level, and companies can come up with solutions for the human workers such as job enrichment or job rotation, in order to keep them motivated. An important thing that employees should realize is the fact that automation could generate other vacant positions within their companies.

X.CONCLUSION

To conclude it is evident from a huge body of research studies that automation produces not only positive effects but some negative effects as well on human work and lives yet the negative effects of automation are far less in comparison to its positive effects. The reluctance to automation comes from the people who are scare of the fact that employees could be partially left aside and the ones who even don't want to learn new things and perform new set of tasks, trainings and requalification. To sustain is to learn and relearn the operation of automated systems. Automation has its limits and should be carefully considered. The results of all the intensive researches and investigations on automation and its impact on human behavior to a larger extent conclude that the driving force that stands for automating the processes is providing possibilities for increased efficiency and productivity in the work places and more comfort in personal lives in this highly advanced age of technological automation. Automation is reducing the stress caused by the workload, burnouts, occupational demands, time and complexities and provides us a lot of time to improve upon the automation processes and induce more creativity in these systems for better and efficient management of work and man force. Therefore automation is changing the landscape not only of organizations but almost all walks of human life. Our efforts are directed to describing approaches for investigating the effects of machine autonomy on human behavior. Our interest is in people's reactions to autonomous machines, rather than the nature of the machines themselves. One significant outcome of this review is also that switching from manual handling of work to automation may generate enormous stress and mismanagement in the processes and systems and thus create psychological concerns. A judicious use of decision making in such situations may prevent these situations, as individuals may be reluctant to delegate or over-delegate, cede decisions to the machine when we should intervene, and intervene unsafely when the machine should be left alone. These concerns should be met and the related should focus on a domain, collision avoidance. Moreover the research and advances in Human Factors and Ergonomics (HF&E) is efficiently used for better management of human behavior in highly automated system.

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