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Abstract:

Industry 4.0 designates the recent digital revolution in the industrial sector, evolving from the comprehensive networking and automation of all the productive areas. Equipment, machinery, materials and products permit to (i) distinguish dealing out environmental settings and current status via sensors; (ii) join them through fixed software; and (iii) progress production procedures in an exclusive method. Additionally, Industry 4.0 exposes new trials to enterprises, especially small and medium-sized enterprises (SMEs). Firms should advance approaches to (i) achieve chances of innovation and digitalization; (ii) expand their processes; and (iii) define innovative business models. Based on these premises, a well-organized political, legal and infrastructural outline is essential to build up a business having an Industry 4.0 approach. Though bigger firms can get ahead through innovation processes and predicting the potential digitalization risks for their business models, SMEs may be in trouble. The present editorial aims to offer relevant research outcomes that has been carried out on such a current and emblematic theme, offering new perspectives and opportunities especially for SMEs.

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Applied Research Towards Industry 4.0: Opportunities for SMEs

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Abstract: Industry 4.0 designates the recent digital revolution in the industrial sector, evolving from the comprehensive networking and automation of all the productive areas. Equipment, machinery, materials and products permit to (i) distinguish dealing out environmental settings and current status via sensors; (ii) join them through fixed software; and (iii) progress production procedures in an exclusive method. Additionally, Industry 4.0 exposes new trials to enterprises, especially small and medium-sized enterprises (SMEs). Firms should advance approaches to (i) achieve chances of innovation and digitalization; (ii) expand their processes; and (iii) define innovative business models. Based on these premises, a well-organized political, legal and infrastructural outline is essential to build up a business having an Industry 4.0 approach. Though bigger firms can get ahead through innovation processes and predicting the potential digitalization risks for their business models, SMEs may be in trouble. The present editorial aims to offer relevant research outcomes that has been carried out on such a current and emblematic theme, offering new perspectives and opportunities especially for SMEs.

Keywords: Industry 4.0; SMEs; technologies; industrial processes; job safety; renewable energy; sustainable development

1. Introduction

Industry 4.0 exposes new trials to enterprises, especially small and medium-sized enterprises (SMEs). Firms should advance approaches to (i) achieve chances of innovation and digitalization; (ii) enlarge their processes; and (iii) define innovative business models [1–3]. The present editorial summarizes all the findings and research activities collected in the Special Issue “Process Industry 4.0: Application Research to Small and Medium-Sized Enterprises (SMEs)”. Many targets were addressed: (i) Describing a growth system founded on sustainable development; (ii) spreading on 4.0 approaches in all productive sectors, e.g., industry and agriculture; and (iii) constantly ensuring a high-degree of safety for work [4–19], encouraging energy efficiency and production development processes [12,19–24] and identifying suitable 4.0 practices and approaches.

2. Industrial Applications

An operative dynamic control approach of a key supplier with many downstream manufacturers [25] focused on intelligent data using analytics-based cloud computing. Numerous doubts are embedded in the supply chain system. Although managing a supply plan is difficult bearing in mind such drivers in traditional outlines, the planned outline perceives the evolving changes

using a specific cloud system. A real-time control, useful for detecting indeterminate scenarios, can be achieved by means of industrial Internet of Things and cloud systems. Exposing the efficiency of the proposed outline, real manufacturing cases and their numerical studies were offered. The current competitive environment stresses more efficient firms. Agent-based simulation of value flow was studied in an industrial process for an SME [26]. A manufacturing system was analyzed for increasing its production capacity with the intention of replying to the customer's increased demand.

The project and application of an optimal travel route recommender organization was explored by examining the data history of earlier users [27]. Information were collected from the travel data derived from mobile tourists during a year. An inherent algorithm was planned to find the ideal route of typical mobile tourists in Jeju, verifying the effectiveness of the planned system.

Furthermore, strategies of sustainable development and energy effectiveness must be followed [22,28–37]. Inside the sector of Industry 4.0, “Smart Energy” can be defined as a level of new energy supply systems [17,20–24], focused on monitoring energy consumption. Following the Industry 4.0 model, agriculture must also adopt appropriate technologies (e.g., precision farming). Increasing energy requests and environmental concerns are the new challenges, which agriculture can meet (in part) by using biomass residues derived from the agro-forestry sector [17,20,21,38].

Underground risk index valuation and prediction were explored by means of a basic Hierarchical Fuzzy Logic Model and Kalman Filter [28]. Usually, many of the accidents that occur in underground facilities are not instant. A well-organized implication system is extremely required to inform of these incidents as soon as possible. Results indicated that the suggested technique is suitable for a correct risk index valuation and forecast. Moreover, a safer future was explored using recent job accidents (from 2012 to 2017) in the primary sector in Italy [39]. Training or educational programs should be strategic for increasing the consciousness on risks, e.g., workers in agriculture [40–42]. Future situations can be discovered following explicit information and dealing with risk factors at different job sites with the concluding aim to found appropriate technical, judicial and working actions to decrease job accidents. Also, workers at the shipyards are strongly subject to unsafe working environments [43]. Seeing the difficulty of the shipbuilding procedure, efficient communications among workers are indispensable, but present communication devices, e.g., wireless technologies, are sometimes inadequate due to shadow areas where the radio bands cannot reach. The proposed solution suggests a mobile communication service throughout shipbuilding inside the ship, permitting both rapid work reports and instructions and fast replies to tragedy occurrence, guaranteeing workers' safety.

3. The Role of Industry 4.0

Regulating innovation management in the aerospace industry signifies a chance for SMEs [44]. Producers can select among many suppliers, which must observe with more necessities and technical conditions. Business chances for SMEs are restricted, but still suppliers must attempt to influence the strategic benefit. Assuming different research, development and innovation platforms, which can established greater profits to firms, would permit for important compensations. Analyzing a Spanish innovative small company, a management system allowed the Spanish firm, e.g., to modernize its innovation activities. Adoption steps taken by the Spanish SME can be adopted by other SMEs.

Resource and information access for SME sustainability during the industrial revolution 4.0 discovered the facilitating and controlling roles of innovation competence and management commitment [45]. The present paper focused on 222 SMEs in Pakistan which applied a sampling technique to allocate the survey questionnaire. Smart-PLS software was used to examine the data, indicating which information can affect both sustainability and innovation competence.

Another study examined the influences that are affecting the use of Industry 4.0 technologies in Peruvian micro, small, and medium enterprises [46], revealing some endorsements that might be helpful for these firms. In fact, there are several barriers and drivers in using Industry 4.0., e.g., lack of information and decision-making [47]. Another paper focused on Romanian SMEs concerning the application of these technology, identifying the thoughts and insights of SME managers in Romania on

Industry 4.0 technology for their business development. Romania is changing from Industry 2.0 to Industry 4.0, exposing a high degree of knowledge on advanced technology, but also few necessary resources for implementing a model based on Industry 4.0. Among the tools useful for implementing an Industry 4.0, an enhanced temperature control performance of a thermoelectric dehumidifier was explored [48]. Reducing the energy consumption by refining the performance of the dehumidifier, it can be applied to numerous control fields. Complications of SMEs in Industry 4.0 applications can be examined by an investigative hierarchy process and a network process [49]. Using new production and management technologies, essential for Industry 4.0, is significant for small enterprises with the intention of keeping up with the competition. Though, most firms look at these necessities in a negative way. Moreover, the role of business model innovation derived from Industry 4.0 was investigated. A business model innovation of providers towards customer process innovation was offered [50]. Findings carried out from 111 German Industry 4.0 providers exposed correlations among Industry 4.0 solutions and benefits for both (i) the solution providers and (ii) process improvements of the customers, revealing both decision-making and research suggestions.

A time-based trend of carbon emissions in the composting process of swine manure was proposed in the background of Agriculture 4.0 [51]. Concentrations of CO₂ and CH₄ were correspondingly examined through the pig-manure composting process to comprehend their effects and to protect a supply chain. Simulation and modeling are the two most operative tools for designing or analyzing a process [52]. In many cases, they are the only conceivable means of making a safe engineering choice for a new notion of process for a large-scale system. Simulations and a test-bed experiment were performed for measuring a low-power digital excitation system. The paper confirmed the system's efficiency. An excitation system is also anticipated to rise the constancy and economic consequence by enhancing existing systems [53], focusing on selected students and establishing an education system prone to a digital excitation system. An adaptive approach built on resource awareness to power-efficient, real-time periodic task modeling on fixed Internet of Things devices was offered [54]. However, the latter devices have restricted competences regarding memory and power. A resource-aware approach was suggested to diminish the hyper-period of input tasks founded on device profiles and to permit tasks of all possible period value, indicating significant developments concerning power consumption. Effects of cooperation on manufacturing were also explored, focusing on safety management [55]. Manufacturing IT needs immediate progress and a new distribution form. The paper investigates the waterfall method which is being used in general manufacturing System Integration projects and the proposed DevOps method, which demands earlier distribution and improvement.

4. Review on Industry 4.0

The Revolution 4.0 interested both industry and agriculture for SMEs [56]. Specific challenges face agriculture along the farming supply chain to permit the working application of Industry 4.0 guidelines. Industry is developing at a much faster rate than agriculture (e.g., Industry 5.0). While, Agriculture 4.0 is still restricted to a few advanced firms. Regardless of the recomences of industry or agriculture 4.0 for large firms, SMEs often face difficulties in such advanced developments owing to the incessant progress in innovations and technologies. Additionally, multiscale and multi-granularity process analytics were revised [57] since they are important for the future of process analytics regarding numerous common activities. The presence of pertinent dynamics at multiple scales turned out to be a shared pattern. Consequently, multiscale methods must be applied with the intention of avoiding biased examination towards a certain scale, conceding the benefits from the stable exploitation of the information content at all scales.

5. Focusing on Costs

Estimating complications in the Internet of Things was offered with multi-criteria decision-making [58]. As an outcome, the degree of importance of the factors instigating such complications was due to multi-criteria decision-making approaches. The chief purpose of the firms

transitioning to Industry 4.0 is the communication of things with each other. This means that enterprises will be able to accelerate the change towards the Internet of Things by minimalizing time and economic loss. An optimal operating schedule for an energy storage system was proposed focusing on efficient energy management for microgrids [59]. A post-Industry-4.0 consumer needs an ideal project and control of energy storage founded on a request prediction, by means of big data, to sturdily supply energy. Finally, a cost-effective redundant digital excitation control system and test bed experiment for safe power supply for Industry 4.0 was offered [60]. Though, such a system is too costly for smaller power plants. The system has enhanced its constancy and dependability at the similar time through double (redundant) configuration. Besides, the system's performance was tested by screening a sequence of control function tests after putting it into the gas turbine used in a thermal power station. Innovative relays were connected after eliminating the power supply in the current panel.

6. Conclusions

A complex but efficient framework was offered by this Special Issue, which is essential to allow industries to face Industry 4.0. Though large firms can forestall the risks of digitalization for their business models, SMEs may be in difficulty for several reason. Consequently, the determination is to advance the 4.0 framework settings, supporting structures to facilitate SMEs to meet future challenges and benefiting from the chances of the fourth industrial revolution.

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