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Machine Learning and SMEs: Opportunities for an improved decision -making process

Aprendizaje automático y PYMES: Oportunidades para el mejoramiento del proceso de toma de decisiones

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Abstract

Objective: Check that machine learning is transforming the way that large companies have relationships with their customers, the design of their products and the management of human resources. The above as a result of a digital transformation that will consequently generate competitive advantages for companies that can quickly adapt their business strategies to the latest technological developments. However, it is proving that SMEs slowly embrace technological innovations, thus assuming a risk of losing the opportunities that Machine Learning offers them. **Results y Conclusions:** Identify and describe the opportunities that Machine Learning offers to SMEs, relating the dimensions of business and technology. First, a literature review is developed. Then, describe in detail the different perspectives in which the adoption of an improved decision-making process will lead to an improvement in organizational performance. Finally, recommendations are given for the development of specific decision-making processes in Machine Learning.

Keywords: SMEs, machine learning, decision-making, management.

Resumen

Objetivo: Revisar que aprendizaje automático está transformando la forma que las grandes empresas desarrollan las relaciones con sus clientes, diseñan sus productos y gestionan los recursos humanos. Lo anterior como resultado de una transformación digital que consecuentemente generará ventajas competitivas para aquellas empresas que rápidamente puedan adaptar sus estrategias de negocios a los últimos desarrollos tecnológicos. Sin embargo, está demostrado que las PYMES acogen lentamente las innovaciones tecnológicas, asumiendo de esta forma un riesgo de perder las oportunidades que el Aprendizaje Automático les ofrece. **Resultados y Conclusiones:** Se identificaron y describieron las oportunidades que el Aprendizaje Automático ofrece a las PYMES, relacionando las dimensiones de negocio y tecnología. En primer lugar, se desarrolla una revisión de literatura. Después, se describe en detalle las diferentes perspectivas en las cuales la adopción de un proceso de toma de decisiones mejorado conlleva a un mejoramiento del desempeño organizacional. Finalmente se dan recomendaciones para el desarrollo de procesos de toma decisiones basados en Aprendizaje Automático.

Palabras claves: PYMES, aprendizaje automático, toma de decisiones, gestión.

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Introduction

In the past, it was assumed that decision-making in a business set up as a rational process where business managers make decisions by collecting, integrating, as well as analyzing data in a mechanistic manner (Simon 1979). However, recent research has demonstrated that the decision-making process tends to be contextual, dynamic, and personal [1,2,3,4,5]. An individual is influenced by the prior experience and knowledge they have. Therefore, most organizations tend to rely on data to make a rational judgment [6] .Despite this, business managers continue to fail making directional decisions when under pressure [7].

Moreover, the ability of individuals to handle large datasets is limited meaning that it is almost impossible to guarantee better decisions based on a human analysis. However, it is possible to improve the quality of data when making a decision through the use of IT tools. These tools are used to improve the quality of the decisions made since it reduces the amount of mental effort, which is need to make decisions. However, most small business managers do not know the availability and relevance of the IT tools that can help them make rational decisions such as machine learning [8]. In overall, machine learning is a rigorous data process, which automates the empirical decision-making process. For this purposes, it uses machine learning models, which recursively learn from data, allowing computers to identify non-trivial insights without being developed explicitly where to look [9].

Machine learning tends to ensure that computer packages are smart this enabling their users to conduct research, identify patterns, spot anomalies, and advocate novel procedures [10]. Currently, customers are provided with smart applications such as the Amazon's advice engine as well as the Apple's Siri. These applications are now part of every day's life of a customer. However, these applications supply data about their users in a smart and easy way. They also provide customers with insights when they need it.

Companies that develop AI systems have now begun to work on broadening the clever apps that small business organizations can use. These include the consumer and accounting systems, human assets and logistic systems. These systems are important in allowing small businesses to run their operations effectively and efficiently. Recent statistics have demonstrated that many established companies that use machine learning have generated insights from data they hold and which is critical to their performance [11].It has also been shown that machine learning is not only useful in the financial industry but also in the telecom, retail, consumer goods, and medical field. Any type of business can use machine learning for their benefit.

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In this sense, the study and review of different authors on the technological processes and management of machine learning generate the following research questions. What are the main difficulties faced by the SMEs to adopt machine learning techniques in their processes? What opportunities does machine learning offer to SMEs? What business-processes can be supported by machine learning techniques? To achieve the above, this article presents in its structure the theoretical review and contribution of internationally renowned authors on issues of technology management and development of SMEs, highlighting the economic dynamics and social importance of SMEs for the development of the World economy. In summary, this paper examines whom small business can use machine learning to better their decision-making process.

Literature review

Statistics and computer science researchers have over the years developed advanced techniques to gain insights from disparate data sets. Typically, this data is from different sources, different data types as well as of different quality meaning that it could be unstructured or structured. It is imperative to note that the advanced techniques tend to leverage on the ability of computer systems to perform tasks including processing the natural language as well as recognizing images from the learning experience. This is what is referred to as the artificial intelligence where computational tools to address the various tasks that traditionally required human sophistication [12]. Today, the application of artificial intelligence and machine learning is used in almost all sectors including in language translation, disease diagnosis and driving cars. Small businesses have also started to adopt information technologies to influence their decision-making process thus making it more efficient [13].

Machine learning refers to the method of designing or describing the sequence of actions to solve a problem otherwise known as algorithms [9]. It is important to note that the algorithms optimize automatically as the computer system continues to learn with no or limited human interventions. Machine learning algorithms are used to find patterns in large sets of data through data analytics techniques from innovative and diverse sources. There are many machine learning tools which are used to build the learning algorithms but most of them are based on statistical models. These tools extend linear regression models with the aim of dealing with millions of inputs as well as using the statistical models to summarize the large dataset for easy visualization [14].

Currently, machine learning algorithms do not only consider linear relationships which tend to dominate the financial and economic analysis but also automates prediction, optimization as well as categorization. To this

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end, machine learning does not necessarily work with data with a causal inference. Typically, there are various categories of machine learning algorithms. The algorithms depend on the level of human intervention which is required when labelling the data to be analyzed [15]. These may include the supervised learning which is where an algorithm is fed with the training data which contains the labels on various portions of the observations [16]. These may include the transactions data set that contains labels on data points that identify ones which are fraudulent and the genuine ones. To this end, the algorithm must learn the general rules of classification which it uses to predict the labels of other remaining observations in the data set [17].

The unsupervised learning is a type of algorithm where data which is provided to an algorithm lacks labels [18]. Therefore, the algorithm must detect the data patterns by identifying the clusters of observations which depend on underlying characteristics which are similar. This may be described by a case where security which has similar features are referred to as illiquid security which is hard to price. Other algorithms include the deep learning algorithm where an algorithm which is inspired by the human brain. The deep learning algorithm is mainly used in such areas as image recognition as well as natural language processing [19]. It is capable of discovering the generalizable concepts including the encoding of the concept of a car from various images.

It is imperative to note that machine learning may be used to tackle various problems including the regression analysis and classification [20]. In this case, the classification algorithms tend to be probability-based and hence the outcome of the results is based on the highest probability.

One of the things that have been noted in machine learning is that it cannot determine causality. In this case, machine learning is only used to identify patterns of correlation of patterns in events. Therefore, the patterns which machine learning identifies tend to be correlations. Most of these correlations are not recognizable when using the human eye [21]. Today, machine learning is being used by economists and management experts to understand various complex relations.

Difficulties and constraints in machine learning implementation for SMEs

Different aspects condition the slow adoption of advanced analytical techniques based on machine learning, in this research, the following ones have been identified, considered the most important and relevant.

Traditionalism and cultural aspects

In general, SMEs do not have a consolidated management team, transferring responsibility for the adoption of new management techniques to the

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owners [22]. This situation can lead to considering machine learning as a workload rather than an opportunity for improvement. Another restriction is the storage of data, in reality, there are few companies that develop a culture of data management, so much that when deciding to implement a machine learning project they find low-quality data or difficult to interpret.

Shortage of qualified personnel

The profession of data scientists has received different evaluations, for [23] this will be the sexiest profession of the 21st century, while [24] defines it as the engineers of the future. This has resulted in an increase in the costs of hiring these professionals and job instability associated with a highly demanded profession. In 2018, the shortage of skilled personnel in machine learning and analytics is estimated at 150,000 to 180,000 people. The salary webpage glassdoor reports an average salary of 142.729 per year for the data scientist in the US, against an average salary of 104.463 for a software engineer. So, it represents a challenge for human resources departments to generate attractive structures for the professional development of young data scientists, creating working conditions where their growth expectations are taken into account.

Study cases and relevant business literature

The case studies are a first-hand source for the generation of knowledge in the SMES [25]. However, there is still not enough development of applied research on the implementation of techniques of machine learning in SMEs, although there are documents that promote among entrepreneurs the advantages of these techniques, such as [26,27], applied and specific machine learning cases in SME are not widely available.

Financial Issues

Different investigations have found that financial problems are one of the main constraints for SMEs to grow and be sustainable over time, for example [28,29,30,31]. This restriction in cash flow for new investments raises the need to involve the processes of development and implementation of machine learning techniques in the strategic planning of the company, going from being business support processes to a fundamental factor for consolidation and company growth.

Areas of Development

Decision-Making

Typically, businesspersons including small business owners tend to have an individual bias when making a decision. This is because they are driven by

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their personal assumptions, which may influence how they think. Science has shown that people tend to have cognitive filters which shape how they interpret information as well as respond to cues. Moreover, the fact that most individuals tend to respond to environmental signals imply that their decision-making process even at the executive level is systematic and not evidence-based [32]. When a manager is under pressure, they resort to making using familiar reasoning as compared to using rigorous analysis. However, with machine learning, small business owners have the capacity to make unbiased decisions. Typically, when business executives make fast and quality decisions, the probability that an organization is likely to be successful in the future are high [33]

Making product recommendations

One of the best ways for small businesses to apply machine learning is developing product recommendation systems. Typically, it is imperative that a small business develops a recommender structure after studying the behaviour of customers. This is exemplified by the recommender on Amazon which is based on data from millions of clients. In this case, Amazon has studied the customer's shopping and browsing behaviour over time and is thus aware of the precise products they are likely to purchase [34]. This allows the company to place the product on the first page when they browse Amazon's website.

Fraud safety and statistics filtering

It has been shown that it is beneficial for small business organizations to apply machine learning for fraud protection and statistics filtering purposes. Those varieties of issues fall into the machine learning bucket called "classification". In case you run a web commercial enterprise, these device gaining knowledge of talents can be even greater crucial to you. Algorithms implemented for fraud safety can help decide whether or not an economic transaction is real or fraud. Based totally on various portions of information inside the electronic mail (and a few facts now not seen via the email reader), algorithms can decide whether or not the email is legitimate or fraudulent. A traditional example of machine learning studying applied to statistics filtering is spam filtering for email [35]. In the financial sector fraud detection systems are used for identify anomalies in credit card transactions [36], in the public sector for detecting under-reporting tax declarations, but not only is used for online or remotes transactions, it is also applied as a point of sale fraud detections as in [37].

Accessing Loans

Machine learning approaches have made it simpler for brand new small enterprise proprietors to comfortably access startup funding and loans from

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different platforms. Access loans are one the best way to improve the operations of a small business [38]. Previously, without machine learning, it was almost impossible for small business organizations to secure conventional business loans. However, today with machine learning, startups with less than six months of operations can secure loans if they qualify based on the transactions which they have carried out in the last few months. Machine learning has revolutionized how small businesses access loans.

Easier social media monitoring

Today, over ninety-five per cent of millennial are online on social media sites. In this case, they make efforts to interact with manufacturers via Facebook. According to [39], forty-two per cent of markers have states that social media sites including Facebook are critical to the marketing process. A research developed in Australia [40] shows that the lack of time and knowledge in management team are critical barriers to effectively implement an automated social management.

With customers posting more than five million pieces of consumer-generated content material on Facebook every day, it is imperative that small businesses understand how this information may be used against them [41]. One of the critical tech tendencies that small businesses may adopt is the of the maximum critical new tech tendencies for social media managers is machine mastering or the synthetic intelligence.

Dynamic pricing, also known as the demand pricing, is where a businessman prices an item based on environmental factors such as the hobby of the target consumer, demand at the time of buy, or whether the customer has engaged with an advertising campaign [42]. This requires numerous statistics about how one of kind clients' willingness to pay for a good or provider adjustments throughout a variety of situations, however via machine gaining knowledge of packages, groups like airlines and ride-proportion services have successfully implemented dynamic charge optimization strategies to maximize revenue [43]. This can also be utilized by upcoming and current small businesses to minimize loss and enhance more profits.

Handling customers

When customer service tickets are available and the provider queue is sponsored up, or it is outside regular operating hours, a chatbot creates automated messages to make clients experience heard while permitting marketers ample time to answer questions and remedy issues [44]. Nevertheless, non-strategic implementation has been the mantra of customer support for too long, so it’s natural for people working in the

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customer service area to have doubts while participating in new automation processes.

Therefore, customer support by itself is naturally a interesting process to develop automation. But, many years of wrong implementations have left this area of business with a lot of negative motives. So, Managers nees to reinvent their initiative and reconsider automation as a strategic process, considering cultural aspects as a main barrier to machine learning.

Handling customers

Customer churn modelling allows small businesses to discover which of their customers are probable of leaving the business. To this end, this allows the company to know how to engage them so that they do not leave. Typically, when a business is incapable of retaining their customers, this may affect their overall growth in the future [45]. With machine learning, the business can use algorithmic retention methods it helps them to optimize price discounts, electronic mail campaigns, or different targeted advertising and marketing projects that maintain their high-value customers [46].

Challenges faced with implementing data-driven models

Several factors determine the failures of SMEs to adopt IT model. Among those, the following ones have been identified, considering its relevance and impact.

Lack of IT Understanding: The Accenture business technology survey shows a significantly low level of understanding of topics related to, Big data, analytics, artificial intelligence and Cloud computing. It is important to mention how conservative SMEs are to adopt new paradigms and probably won't invest resources in a new venture without having a full understanding of the benefits they could get.

Skilled manpower attraction: The lack of management expertise to create careers plans that could reach to the interest of young data scientist is a threat for SMEs looking for developing a data-driven culture. One important issue is the performance evaluation system of the data analyst, most of the traditional compensations systems cannot fully recognize a talented worker because of a short-term vision of the results.

Cultural Constraints: From a conservative and sceptical point of view, most of the data solutions may be considered as a well-presented propaganda rather than an opportunity for improvement and growth. And despite the evidence, most of the managers still consider the empiric knowledge as valuable and essential.

Shortage in the labour market: Due to the high salaries that data scientist are receiving and the dynamic labour market, it is difficult to recruit good

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profiles to create a data team in SMEs. In this case, better than offering a high salary it should be better to really offer a challenge to the worker, in reason of the scope of the solution intended.

Software Integration: It is true that exists a great offer of analytics software solutions on the market. But for a SMEs manager, most of the packages are no clear about the parallel resources needed to make the most of the software solutions. Eve, it is hard to find and unbiased evaluation of software in the literature.

Management model integration: To fully get the maximum value of the data through machine learning models, the company needs to integrate its managerial concepts and the organizational framework to a data-driven approach. The idea is to avoid misunderstandings, creating flows of communications and delineating a constructive system able to build and sustain the data solutions over the time.

Data Privacy: The data process must follow legal patterns about protecting customers data. But, it is important to mention that always the technological development will be faster than the regulation path. So, in this aspect the ethical culture of the company plays a key role, developing a self-regulation process.

Financial Aspects: It is known that SMEs faces limitations in order to make large investments in technology, it is also true that they have fewer access to financial leverage than the larger organizations. However, does exists public and private funds that promote the implementation of data technologies in SMEs. On the other hand, SMEs have a great ability to create alliances due to its flexibility and size, this challenge seems to be critical but does exist options to overcome it.

Evaluating SMEs Opportunities with Machine Learning

The implementation of a Machine Learning program in SMEs involves necessarily an initial evaluation of their business and technological dimensions integration, regarding the use of data as a strategic asset and source of valuable information to get an overall improved performance. So, the initial evaluation of the company's integration can be developed in a regular way by implementing an appropriated reference scheme that contemplates a full characterized set of circumstances, where technology and business can be mapped holistically. In this research, an evaluation scheme is proposed, aiming to classify and diagnose the current level of integration when a data-based approach will be considered, becoming in that way in the foundations for the implementation of a plan for machine learning applications in the organization.

For big companies, the evaluation activities can be carried out by externals companies, but in the SMEs context it is different and most of the standards

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evaluations schemes doesn't consider the intrinsic features of companies in the path of transition from an empiric decision model to a data-driven approach. Based on the before mentioned, the following business and technological dimensions are proposed.

Long-term vision: The stage at which a data-based decision-making will be taken into account to design the future of the company, setting a business strategy to improve operational performance and enhance the innovation capacity.

Leadership: how the top direction supports, conceive and foster the implementation of new IT approaches, concerning the use of data as the key driver of the business operation.

Corporative culture: How wide is the company commitment to promote and share a data-centred management, encouraging the formalization of the tacit knowledge into a formal and structured system of learning and improvement.

Infrastructure: Aspects related to the hardware architecture that support the collection, administration, safety and transmission of data.

IT Skills: How in the company the different aspects of implementing a data-driven approach are developed (e.g., software skills, business insights analytics, etc.).

Data Management: Processes related to data storage and the integration with business partners, not just for transactional operations but also for prediction, planning and forecasting.

Based on the evaluation dimensions listed above, an evaluation model is proposed in table 1. Pointing out the dimensions of the model related with each challenge.

Tabla 1. Relations between the challenges and Dimensions in the evaluation model

	Dimensions					
	Business			Technology		
Challenges	Long-term vision	Leadership	Corporative culture	Infrastructure	IT Skills	Data Management
Lack of IT understanding	***	*			***	
Skilled Manpower retention			***	**	***	
Cultural Constraints			***			

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Shortage in the Labor market		***			***	
Software Integration				**		***
Management model integration		***	*			**
Data Privacy		**		**		***
Financial Aspects	***	***			*	

Source: Own production

The result of the evaluation model considers the following profiles of companies:

The operative profile: Companies with a strategic vision based on the management of all aspects related to data. Considering this profile as an easy adopter of new technologies.

The strategic profile: Companies with a complete business understanding and assessment of the benefits of new IT models, but with no operational skills to undertake machine learning implementations.

Discussion

The use of machine learning for decision-making among small business owners is an emerging discipline and therefore there is no definitive list of actions that small business owners should take [47]. From the studies that were reviewed, the following themes were identified:

There is a great interplay between IT knowledge and decision-making process. To this end, insights tend to inform the decision-making process [48]. However, deliberation and investigation provide business owners with new insights such as customer behavior which can be used when one wants to take a decision that involves risks [49].

Machine learning and artificial learning can identify patterns and relations but there is a need for a human dimension to interpreting this information. A small business must plan to meet the needs of the customer even before it considers implementing a machine learning algorithm. To this end, these businesses must plan to meet the customer's need so that it ends up with satisfied customers [50]. Moreover, what is important is ensuring that the customer relationships, customer's perceptions, and customer satisfaction are improved even though intangible.

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Conclusion

In the development of the article, the technological and business dimensions have been related holistically, identifying the challenges and opportunities that machine learning offers to SMEs. Thus, in the context of adopting a decision-making process supported by new technologies by the SMEs, it is defined as a complex and multifaceted situation, involving different aspects of the company's organizational structure such as Leadership of senior management, infrastructure requirements, labour market, legal aspect, information management and expert consulting.

In conclusion, the need arises for companies to take the first step of approaching technologies based on machine learning, considering the process of customer management as an excellent starting point given the familiarity existing by companies to generate constantly new knowledge about preferences, attitudes and purchase intentions of its clients. In such a way, the generation of an organizational knowledge associated with the good management of customer data allows a transversal way to solidify each of the determining dimensions in a decision-making process supported by automatic learning.

It is shown how big corporations get real benefits from machine learning because they can afford to buy or develop systems based on machine learning technologies, However small companies are sometimes incapable of buying or developing systems based on machine learning due to the high capital investment required. Small businesses must only use systems based on machine learning when they have fully identified a specific business domain, assuring that it will help them to gain a competitive advantage, without compromising its reputation, financial stability, business vision and legal aspects.

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