

Impacts of Industrial Revolutions on the Enterprise Performance Management: A Literature Review

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Abstract

Purpose - Developments in the industrial revolutions also influence enterprises which are indispensable for commercial life, as well as social and cultural life. These changes which occur in the enterprises about production methods and technologies with the revolutions, naturally affect all the processes of the enterprises, and the methods and tools used also change. As structures of enterprises change the ways in which their performances are evaluated, inevitably change. The methods of evaluating the performance of progressively growing businesses also have to change inevitably and get more complicated. It is obvious that enterprises need to evaluate their performance in order to survive and reach business excellence. Enterprise performance management is an important tool which is driven by strategies of the enterprises and pushes the enterprises to use their resources effectively at the same time. Therefore in this study, interaction of enterprise performance evaluation methods with the facts up to the Industry 4.0 is discussed in the historical development process.

Method - Literatures on the enterprise performance evaluation methods up to the 2010 and the industrial revolutions up to the Industry 4.0 were researched and the relations between the facts have been tried to be established.

Findings - When the results are evaluated, developments in the field of enterprise performance management have taken place with the first, second and third industrial revolutions. These developments have gained momentum especially in the Industry 3.0 and the most known and the most used methods in the field of enterprise performance evaluation have emerged in this period.

Limitations - In this study, the effect of industrial revolutions on the field of enterprise performance management is evaluated by examining the relationship between industrial revolutions and enterprise performance evaluation methods. In future studies, this impact can be evaluated by examining the relationship between the different facts in the field of enterprise performance management and the industrial revolutions.

Implications – Industrial revolutions have profoundly affected the field of enterprise performance management as well as every area of life and will continue to affect. It is expected to be used the artificial intelligence techniques which form basis of the fourth industrial revolution, in the future studies at the field of enterprise performance management.

Originality – The significance of this paper is examination of the impacts of industrial revolutions up to the Industry 4.0 on development of the field of enterprise performance management. This study will pave the way for better predictions about how the fourth industrial revolution will create a trend in the field of enterprise performance management.

Keywords: industrial revolutions, enterprise performance management, enterprise performance measurement, performance measurement models

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Introduction

All developments in the history are mainly originating from the needs of human beings and the industrial revolutions that occurred and are coming are the result of these needs. The first industrial revolution (the Industry 1.0), the second industrial revolution (the Industry 2.0) and the third industrial revolution (the Industry 3.0) were respectively realized through mechanization, electricity and information technology. At the beginning of the Industry 1.0, there was domestic production. Towards the end of the Industry 1.0, it was began to shift to textile mills, which we can call the first modern enterprises of that time. As a result of the industrial revolutions which have occurred, the technology has developed gradually, but of course, the developing technology has brought new problems.

Enterprise performance evaluation is very important for businesses to maintain their assets. Prior to the Industry 1.0, the domestic system was dominant in production, and the performance information in the simplest sense was provided only by registrations held by traders in order to record past exchanges and to keep track of highly disorganized stocks. Then the first modern commercial enterprises of that time began to emerge and subsequent developments led to the inevitable change in the area of enterprise performance evaluation. Therefore, new methods were needed to evaluate the performance of developing enterprises.

The Industry 1.0, first appeared in the textile, iron and coal production and water transport sectors in the UK in the 1700s (Weetman, 2016), and was later seen in eastern Europe and the United States in a few decades (World Heritage Encyclopedia(a)). The invention of the steam engine by James Watt in 1788, the use of coal instead of wood as the energy source, the use of machine power instead of human or animal power, the first application of internal combustion engines, the transformation of chemical energy obtained from coal into thermal energy and mechanical energy are significant developments which made this revolution possible.

The Industry 2.0, also known as the Technological Revolution, has emerged as a result of changes in energy resources and basic raw materials. In this period oil, steel, electricity and chemicals as well as steam, coal and iron were used in the production processes. Internal combustion engine, telephone, microphone, gramophone, radio, lamp, car tire, bicycle, typewriter, cheap newsprint are the innovations of this revolution. The impacts of the Industry 2.0 have been extensively seen in the United States, Germany and the United Kingdom, as well as in France, the Low Countries (geographical region including Belgium, Luxembourg and the Netherlands) and Japan. It is thought that the Industry 2.0 started in 1860 with the invention of the cheap steel production method by the British Inventor H. Bessemer and reached its peak in the mass production and production line prior to the first world war as a result of the enormous increase in early factory electrification through the spread of this method (World Heritage Encyclopedia (b)).

The Industry 3.0 which is characterized by the automation and digitalization of production, is the result of developments such as the discovery of nuclear energy and the invention of computers (Evan & Manion, 2002). The determinative features of this period were innovations in areas such as biogenetic, synthetic materials, microelectronic technology, fiber optics, biotechnology, laser technology, nuclear energy, computer technology, and telecommunication. As a result of the revolutions that occurred, oil and other fossil fuels started to run out and the technologies acquired and sustained by these energy sources began to become obsolete and got difficult to maintain their sustainability. Worse still, the annoying effects of climate change resulting from fossil fuel-based industrial activities have increased, ecosystems have deteriorated and natural disasters have reached tremendous levels. For all these reasons, renewable energy sources such as solar and wind have become important and the concept of sustainability has come to the fore.

Due to the increasing conditions of competition, enterprise performance evaluation is vital and becomes increasingly complex for different reasons. In this study, the historical development of enterprise performance evaluation is analyzed in relation to the revolutions up to the Industry 4.0. The aim of this study is to help the researchers to make predictions for the future and to help them make sense of the

trends, based on the historical relationships between industrial revolutions and enterprise performance management.

Historical Development of the Enterprise Performance Management Field Taking into Consideration the Industrial Revolutions up to the Industry 4.0

The area of enterprise performance management is examined in four main periods based on the industrial revolutions up to the Industry 4.0 as shown below;

Enterprise Performance Management for the Pre-Industry 1.0 Period

Before the first modern commercial enterprises emerged, the domestic system was dominant in production and in this system raw materials were transformed into products by the mutual cooperation of merchants and artisans. While merchants provided the necessary raw materials to the artisans, the artisans were transforming these raw materials into products. In return for this production, merchants were paying to the artisans a piece-by-piece and selling finished products in the markets. Market prices provided all the managerial information that merchants needed, while merchants kept accounts to record past exchanges and to keep track of highly dispersed stocks. It was clear, therefore, that they did not keep these accounts in order to provide decision and control information (Johnson, 1981).

Along with merchant entrepreneurs began to coordinate the textile-making processes at the central business locations, market prices were insufficient to provide the needed knowledge. With the wage contracts carried out in this new factory system, the employees started to be paid hourly instead of part-time payment. In addition, as non-labor conversion inputs were provided from within the company, managers considered it necessary to explain the internal conversion costs (Johnson, 1981).

Enterprise Performance Management for the Industry 1.0 Period

The first modern business organizations which needed internal accounting information for decision-making and control, were mechanized, multi-process textile mills in the UK and the United States around the 1800s. These textile mills used double-sided cost calculations to determine the direct labor and fixed costs of converting the raw material into finished yarn and fabric (Johnson, 1981). According to historians, cost records of the factories which are integrated, multi-process textile mills, such as Charlton Mills in England (Stone, 1973), Boston Manufacturing Company during the 1820s and Lyman Mills Company, a cotton textile company founded in Boston in 1854, are the oldest

ones known up to now. These new records which include labor costs, the daily movement books recording the cotton pound transformed every day in the textile processes and general expenses, were kept to make short-term decisions and to control the conversion of raw materials to finished products (Johnson, 1981).

Enterprise Performance Management for the Industry 2.0 Period

During the 1850s and 1860s almost all of the basic techniques of modern accounting were discovered by the executives of the major American railways. New accounting practices were divided into three categories as financial, capital and cost accounting. The “operating ratio” that companies began to use in the late 1850s was a standard way to assess the financial results of a railway as well as balance-sheets. The type of renewal accounting that was specified by the 1870s was the standard form of capital accounting used by American railways and their repairs and renewals was charged to operating expenses, not in capital or fixed assets accounts (Chandler, 1977). The mass-production enterprises were established in the 1880s for the production of tobacco products, matches, detergents, photographic films and flour, and these enterprises adapted the internal accounting reporting systems of the railways to their own organizations. The most important was the emergence of the metal making and manufacturing industries. One of the most famous steel companies of that period was Carnegie's steel company (Kaplan, 1984). Although Carnegie and her colleagues did not generally deal with overheads and depreciation, their interests were almost exclusively focused on basic costs. Due to the long-term economic crisis of the 1870s, manufacturers began to turn their attention from technology to organization, and this new interest led to the first steps of the scientific management movement in the American industry (Chandler, 1977). The scientific management approach, in which names such as Frederick Taylor, A. Harrington Emerson, Hamilton Church and Henry Towne contributed to the emergence and development of, included not only the development of business standards, but also a new form of organization (Kaplan, 1984). The names such as Garcke and Fells (1887), A. Hamilton Church (beginning of 20th century) and J. Maurice Clark (1923) also contributed to cost accounting, while the use of break-even point graphs can be found in written works in the UK and the USA in 1903 and 1904 (Solomons, 1968); and in the mentioned studies, it was generally focused on the general expenses and how to allocate them. Typical manufacturing firms in the middle of the 19th century were transformed into vertically-integrated industrial firms, as seen in the large number of mergers between 1897 and 1903 (Johnson, 1975b). Thus, the organizations at unitary form emerged (Johnson, 1975a), and these enterprises included the design of complex accounting systems to carry out evaluations, transactions and planning across the firm (Johnson, 1975b).

In 1903, the DuPont Powder Company was transformed into a vertical-integrated company while it was formerly a single-function company (Johnson, 1975b) and F. Donaldson Brown also found the DuPont system in 1914, expanding the ROI approach

in about 1912 (Kaplan, 1984; Mark and Birkinshaw, 2015). Despite the aforementioned developments, in 1917 modern industrial enterprises still had structural weaknesses and the administrative class was just beginning of professionalization. DuPont and other new managerial businesses in the field, which were segmented according to central and functional, had serious flaws in the coordination of flows and the allocation of resources. Due to the severe economic recession that occurred from the summer of 1920 until the spring of 1922, there was a sudden and permanent decline in demand. In addition to Du Pont, General Electric, United States Rubber and other large enterprises, General Motors and Sears Roebuck responded to the stock crisis of 1920-1921 by developing techniques to determine and correct their flows according to carefully presumed future demand (Chandler, 1977). Du Pont and General Motors went further and developed a new form of organizational structure called the multi-divisional firm (Kaplan, 1984). General Motors' managerial accounting system introduced regulations that would help senior management to achieve "centralized control with distributed responsibility" (Johnson, 1978). By the 1930s, process engineers in France were guided to explore ways to improve production processes through better understanding of cause-and-effect relationships (Epstein and Manzoni, 1998) and as a result of these efforts a performance management system called Tableau de Bord, which is usually seen equivalent to the American Balanced Scorecard, was developed (Pezet, 2009). Enterprises performance evaluation methods in the Industry 2.0 period are described as the following in Table 1;

Enterprise Performance Evaluation for the Industry 3.0 Period

The limitations of ROE and ROI opened door for the search of alternative measures, although these measures were still based on the financial statements (Arnaboldi et al., 2014). One of these indicators is the residual income that emerged as the expansion of the ROI criteria in the period after World War II (Kaplan, 1984). In multi-divisional firms, the problem of transfer pricing related to the price of goods or services sold among business units in the same company may be a problem, but this problem could help companies to monitor the profitability of each segment (Collier et al., 2013). The mainstream approach, which began in the field of management accounting in the 1960s, was the application of numerical models to various planning and control problems. This literature which was encouraged by the development of operations research after the Second World War, described how analytical methods could be applied to cost accounting problems (Kaplan, 1984). The last 15 years are defined by the application of knowledge economy and agency theory to management accounting problems (Kaplan, 1984). The transaction cost economy, which emerged in the 1970s. It is a variation of the agency theory and very suitable for internal audit (Spraaakman, 1997).

Yadav et al. (2013) examined the enterprises performance evaluation methods in 3 periods in their respective study. Therefore in this study, enterprises performance evaluation methods developed during the Industry 3.0 are examined in three main periods as 1945-1990 period, 1991-2000 period, 2001-2010 period. Enterprises

performance evaluation methods in the Industry 3.0 period are described as the following in Table 2 – Table 22.

1945-1990 Period

In this period, not only performance measurement frameworks based on financial measures, but also multi-dimensional performance measurement frameworks were developed. Management and cost accounting have been further developed and the concept of the social responsibility for enterprises has emerged for the first time in enterprise performance evaluation. In addition, the enterprise performance management area has begun to be linked to the strategies of the enterprises with the new accounting methods developed. Furthermore, quality concept has gained importance in the field of enterprise performance management with the methods based on total quality management principles.

1991-2000 Period

In this period, not only the methods based on financial measures, but also a balanced combination of financial and non-financial measures have been developed. In addition, causal relationships are considered and quality is also emphasized. During this period, a sustainability-oriented performance measurement system was developed for the first time. Conceptual maps, cause-effect diagrams and multi-criteria decision-making techniques are used in performance measurement methods. Performance measurement has begun to become more connected to strategies.

Companies have begun to lose market share against overseas competitors that can provide better quality products with lower cost and more variety. In order to regain competitive advantage, companies need not only to change their strategic priorities from low-cost production to quality, flexibility, short preparation time, reliable delivery, but also they applied the new philosophies and technologies of production management (e.g. computer integrated manufacturing, flexible manufacturing systems, just in time production, optimize production technology and total quality management). The implementation of these changes revealed that traditional performance metrics have many limitations and require the development of new performance measurement systems for success (Ghalayini and Noble, 1996).

2001-2010 Period

In this period, the methods developed based on the Balanced Scorecard as well as the methods focusing on the various stakeholders of an enterprise are noteworthy. Developed performance measurement methods generally have a holistic performance perspective.

Table 1: Performance measurement frameworks/models taking into consideration the Industry 2.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p><i>DuPont System</i></p> <p>(These references are used for the method: Parrino et al., 2011; Mark and Birkinshaw, 2015; Bruns, 1998)</p>	Brown, 1914	The system is used to calculate firms' return on equity (ROE).	Net profit margin, total asset turnover, financial leverage	The DuPont system provides a way to examine the underlying factors of a firm's profitability as well as it's an easy and practical approach, it's also a good method to examine how the rates of a company change over time and to compare two similar companies.	But like other financial analysis methods, the DuPont system doesn't reflect the current situations in the firm, it doesn't consider the cost of capital of the firm, besides being cost-oriented of the method provides a historical perspective, it gives little indication of future performance and encourages short termism.
<p><i>Tableau De Bord</i></p> <p>(These references are used for the method: Pezet, 2009; Epstein and Manzoni, 1998; Lebas, 1996; Bourguignon et al., 2004; Bessire and Baker, 2005)</p>	Process engineers, 1930s	The French Tableau De Bord which is generally seen equivalent to the American Balanced Scorecard, is a performance management system which is developed while seeking ways to improve production processes by better understanding cause and effect relationships.	Financial measures, quality measures, social measures, customer-focused measures, process-focused measures	Tableau De Bord is designed as a "balanced" combination of financial and non-financial indicators and is more than just a single document, too much value can be obtained from Tableau De Bord's development process.	While the method is more interested in daily operations, it's less interested in strategic issues.

Table 2: Performance measurement frameworks/models at the 1945-1990 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<i>Residual Income</i> (These references are used for the method: Arnaboldi et al., 2014; Kaplan, 1984)	Marshall, 1890	Due to the limitations of ROE and ROI, the method emerged by being developed of ROI criteria in the period after the second world war.	Net operating income, cost of capital, invested capital	It takes into account the cost of capital of the firm and eliminates the shortcomings of the ROE and ROI.	Non-financial measures are not considered, the approach is not widely adopted.

Table 3: Performance measurement frameworks/models at the 1945-1990 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p>Social Accounting</p> <p>(These references are used for the method: Basu, 2009; Everett and Neu, 2000; Lehman, 1999)</p>	<p>A group which consists of accounting scientists, 1970s</p>	<p>It advocates that large companies also have responsibilities towards people outside their shareholders.</p>	<p>Fringe benefits which are given to employees, pension arrangements for employees, health and safety measures, employee training programmers, industrial relations, pricing policies related to goods and services provided, quality control on the products sold, the integrity of the advertising campaigns, pollution controls and energy conservation.</p>	<p>The method also addresses some stakeholders apart from an enterprise's shareholders.</p>	<p>From a critical accounting perspective, it is argued that the social accounting has legalized the current situation by providing mistake to the development which can be made by companies and by no questioning the role that capitalism plays in maintaining different, exploiter social relations, Lehman (1999) states that methodological and useful trends within the reform accounting models can stop the formation of more serious and explanatory models.</p>
<p>Strategic Management Accounting</p> <p>(These references are used for the method: Simmonds, 1981; Tayles, 2011; Langfield-Smith, 2008)</p>	<p>Simmonds, 1981</p>	<p>The method is defined as the provision and analysis of management accounting data about a business and its competitors to be used in developing and following the business strategy.</p>	<p>Strategy, goals, customers, employees, processes, information</p>	<p>The method is more related to strategy rather than tactic, environmental or marketing-oriented, it focuses competitors and is long-term, it looks forward and is outward-oriented.</p>	<p>The concept itself is not largely understood, and its methods or techniques are not widely adopted.</p>

Table 4: Performance measurement frameworks/models at the 1945-1990 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p><i>Business Excellence Models</i> (This reference is used for the method: Rocha-Lona et al., 2008)</p>	<p>Quality organizations, the end of the 1980s</p>	<p>Business Excellence Models (BEM) are quality management frameworks based on enterprise performance criteria created throughout the development of total quality management principles.</p>	<p>Dimensions vary according to each Business Excellence Model.</p>	<p>The implementation objectives of the Business Excellence Models vary according to the priorities of the organizations and some of these identified objectives are participation to reward, self-evaluation, business process improvement, measurement systems and strategic planning.</p>	<p>Models are a self-assessment rather than an objective measurement framework, the categories for measurement are very broad, and some dimensions cannot be measured.</p>
<p><i>Activity Based Costing</i> (These references are used for the method: Fabozzi et al., 2007; Wyatt, 2012; Neely, 2004; Mark and Birkinshaw, 2015)</p>	<p>Kaplan and Cooper, 1988</p>	<p>Activity-Based Costing (ABC) is an expanded cost allocation process which assigns indirect costs firstly to actual activities and then to products based on their usage the activities.</p>	<p>Raw material cost, labor cost, general production cost (machine activity pool, assembly activity pool, quality control activity pool)</p>	<p>It resolves mistakes in evaluating the manufacturing cost of parts, the approach has been extremely supported in the past by both academics and consultants, ABC is especially valuable in the complex production environment where many products use the same inputs and is strong clearly recognizing the importance of activities and processes.</p>	<p>Many businesses have chosen to avoid from this technique, believing that the approach is too complex, and the method is weak due to the fact that it doesn't reattach the processes to strategies or stakeholders.</p>

Table 5: Performance measurement frameworks/ models at the 1945-1990 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<i>Sink and Tuttle Model</i> (These references are used for the method: Sink and Tuttle, 1989; Tangen, 2004)	Sink and Tuttle, 1989	The model asserts that the performance of an organization is a complex interrelationship between the seven performance criteria: effectiveness, efficiency, quality, productivity, quality of work life, innovation, and profitability/budgetability.	Effectiveness, efficiency, quality, productivity, quality of work life, innovation, profitability/budgetability	Although many things have changed since the model was first introduced, the seven performance criteria are still important.	The model has some major limitations, for example the model does not consider the need for flexibility and the customer point of view.
<i>Maskell Model</i> (This reference is used for the method: Maskell, 1991)	Maskell, 1989	It's a useful model which is developed for American companies with the slogan performance measurement for world class manufacturing.	Delivery success and customer service, process time, production flexibility, quality, financial-based measures, social issues	The model provides a balanced measurement that financial and non-financial performance metrics coexist.	The model is more inter-oriented and some stakeholders are not included in the model.

Table 6: Performance measurement frameworks/ models at the 1945-1990 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p><i>Performance Measurement Matrix</i></p> <p>(This reference is used for the method: Neely et al., 1995)</p>	Keegan, Eiler and Jones, 1989	The method's power lies at the way that it seeks to integrate different dimensions of performance and at the fact that it uses extensive terms such as "internal", "external", "cost" and "non-cost" which develops its flexibility.	Internal, external, cost and non-cost	The inherent flexibility of the method provides that it can adapt to every performance dimension which fits its frame.	Due to the fact that the inherent flexibility of the method will bring subjectivity about the addition of new measures, the success of the measurements will be affected from this.
<p><i>Success Dimensions</i></p> <p>(This reference is used for the method: Maltz et al., 2003)</p>	Shenhar and Dvir, 1990	The model is a multidimensional approach which defines effectiveness against three organizational levels (project, business unit and company) and four time preferences (very short, short, long, very long time preferences).	-	-	The main constraint of the method is that it does not provide specific operational measures for each dimension, the model is not tested at the enterprise level while it is experimentally tested at the strategic business unit and project levels and there is lack of focus on a company's human resources dimension.

Table 7: Performance measurement frameworks/models at the 1945-1990 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p>Performance Measurement Questionnaire</p> <p>(These references are used for the method: Ghalayini and Noble, 1996; Ghalayini et al., 1997; Dixon et al., 1990)</p>	Dixon, Nanni and Wollmann, 1990	The model was developed to assist managers in identifying the improvement needs of the organization, to determine supporting degree of current performance measures to improvements and to create an agenda for performance measurement improvements.	Quality, labor productivity, machine productivity	The method provides a mechanism to describe the company's improvement areas and their associated performance measures and tries to determine the supporting degree of current measurement system to such improvement areas.	The method cannot be considered as a comprehensive integrated measurement system and does not consider continuous improvement.
<p>Customer Value Analysis</p> <p>(This reference is used for the method: Taticchi and Balachandran, 2008)</p>	Customer Value, Inc., 1990	It is aimed that the method is a performance measurement system which is especially directed by the market, by detecting all performance measures around market parameters.	-	The model works with the tools such as value pricing charts, benchmarking analysis, product features-score comparison, priorities chart.	Excessive focusing on the market, which is the main feature of the model, is also a limiting factor.

Table 8: Performance measurement frameworks/models at the 1945-1990 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p><i>Strategic Measurement Analysis and Reporting Technique</i></p> <p>(These references are used for the method: Cross and Lynch, 1988-1989; Ghalayini and Noble, 1996; Lynch and Cross, 1991; Ghalayini et al., 1997)</p>	<p>Wang laboratories, 1988-1989</p>	<p>The aim is to establish a management control system with performance indicators which are defined in order to define and maintain success.</p>	<p>Market, financial, customer satisfaction, flexibility, productivity, quality, delivery, cycle time, waste</p>	<p>The main strength of the method is its attempt to integrate operational performance indicators with company goals.</p>	<p>The system neither provide any mechanism to identify key performance indicators, nor it explicitly combine the idea of continuous improvement.</p>

Table 9: Performance measurement frameworks/models at the 1991-2000 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p>Results and Determinants Framework</p> <p>(These references are used for the method: Fitzgerald et al., 1991; Neely et al., 2007)</p>	Fitzgerald et al., 1991	Reflecting the concept of causality which emphasizes that the results obtained today are a function of past enterprise performance	Competitiveness, financial performance, quality, flexibility, resource utilization, innovation	The results are defined as lagging indicators and the determinants are defined as leading indicators.	Non-financial measures, stakeholders and the importance of their behavioral aspects related to performance have been neglected.
<p>Measures for Time-Based Competition</p> <p>(This reference is used for the method: Neely et al., 1995)</p>	Azzone et al., 1991	The method tackles employ time as a way of competitive advantage.	R & D - engineering time, operations - throughput time, sales and marketing -order processing lead time	The measures of the method reflect the productivity and effectiveness dimensions of performance.	Quantitative measures are not enough for performance management.

Table 10: Performance measurement frameworks/models at the 1991-2000 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p><i>Economic Value Added</i></p> <p>(These references are used for the method: Sherman, 2015; Kapil, 2010; Mark and Birkinshaw, 2015)</p>	Stewart, 1991	Both debt and equity capital are included in the cost of capital.	Financial measures	It gives high-grade results, reduces the problem of agency by helping the company to bring the shareholder interest to the same level with administrative interest and reduces the problem of proxy and is closely related with the marketing value of the company.	The method is unsuccessful at looking to future, only financial measures are not sufficient to measure the performance of the enterprise.
<p><i>Integrated Performance Measurement</i></p> <p>(This reference is used for the method: Yadav et al., 2013)</p>	Nanni et al., 1992	It is emphasized service-focused approach rather than the product-focused approach of traditional management accounting.	Financial measures, strategic measures, operational measures	The method integrates management accounting field with strategic and operational perspectives and has developed management accounting intellection.	The method is not sufficient to measure enterprise performance because some performance dimensions are neglected.

Table 11: Performance measurement frameworks/models at the 1991-2000 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p><i>EFQM Excellence Model</i></p> <p>(These references are used for the method: Trompenaars and Coebergh, 2014; Lawson et al., 2007; Neely et al., 2007; Neely and Adams, 2001; EFQM, 2012).</p>	<p>European Foundation for Quality Management, 1992</p>	<p>It's a business excellence model which assesses organizations for the European Quality Award and is developed based on the concepts of total quality management and sustainable excellence.</p>	<p>Leadership; people; strategy; partnerships and resources; processes, products and services; people results; customer results; society results; business results</p>	<p>The model presents a comprehensive performance idea addressing many areas of performance, emphasizes clearly inputs of performance improvement and shows the areas of results that need to be measured.</p>	<p>The model is a self-assessment rather than an objective measurement framework, the categories for measurement are very broad, while the results can be measured easily some of the inputs cannot be measured.</p>
<p><i>Balanced Scorecard</i></p> <p>(These references are used for the method: Neely et al., 2007; Ghalayini et al., 1997; Ghalayini and Noble, 1996; Kennerley and Neely, 2004; Kaplan and Norton, 1992)</p>	<p>Kaplan ve Norton, 1992</p>	<p>The method provides a balanced measurement by combining financial measures with non-financial measures.</p>	<p>Customer, financial, internal business, innovation and learning</p>	<p>The method more clearly connects performance measurement to the strategy of enterprise, prevents suboptimization, and provides a balanced measurement.</p>	<p>The method does not address some characteristics of the previous performance frameworks, does not include perspectives such as human resources and employee satisfaction, supplier performance, product/service quality and environmental/community aspects to the framework and is not selected and applicable for the level of factory operations.</p>

Table 12: Performance measurement frameworks/models at the 1991-2000 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p><i>Triple Bottom Line</i></p> <p>(These references are used for the method: Polaine et al., 2013; Parsons, 2008; Christopher, 2010; Hubbard, 2009)</p>	<p>Elkington and SustainAbility company, 1994</p>	<p>It is a useful measurement framework which is derived from sustainability field, in order to both provide design instructions and evaluate results.</p>	<p>Environmental, economic, social</p>	<p>The method is useful while working with public institutions, but it is also increasingly popular in the private sector, the method involves many performance measures.</p>	<p>Measuring performance by measures of the method is not a simple task, the method has not succeeded in penetrating to enterprise performance systems and is seen very complex by some managers.</p>
<p><i>Service-Profit Chain</i></p> <p>(These references are used for the method: Mark and Birkinshaw, 2015; Heskett et al., 1994; Ennew and Waite, 2013; Wirtz et al., 2012)</p>	<p>Heskett et al., 1994</p>	<p>The method establishes relationships between profitability, customer loyalty and employee satisfaction, loyalty and productivity.</p>	<p>Internal service quality, external service value</p>	<p>The method handles two of the most important stakeholders of an enterprise, namely the customers and the employees, the causal links in the method are well-structured.</p>	<p>The method has been developed for service firms, does not explicitly address issues related to cost of quality, focuses more on revenue than profit, retention can be behavioral rather than attitudinal.</p>

Table 13: Performance measurement frameworks/models at the 1991-2000 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<i>Return on Quality</i>	Rust et al., 1995	The method is developed to make quality expenditures financially understandable.	Financial measures	The method does not necessitate any specific measurement approach and promotes quality in enterprises.	The method focuses on service quality, it must be verified that the model is generalizable to various industries.
<i>Cambridge Performance Measurement Design Process</i> (This reference is used for the method: Bourne et al., 2000)	Neely et al., 1996	The method was developed to design the performance measurement system.	-	The method guides each enterprise in designing its own performance measurement system.	In order to be able to determine the validity of the method, it has to be applied in different industries.

Table 14: Performance measurement frameworks/models at the 1991-2000 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p><i>Input-Process-Output-Outcome Framework</i></p> <p>(These references are used for the method: Brown, 1996; Neely et al., 2007)</p>	Brown, 1996	The method sees the performance management as a process.	Input measures, process measures, output measures, outcome measures	The model is useful in seeing the difference between the different measurement categories, and separating the output and the outcome measures has made it popular especially in the public sector.	The model assumption that there is a linear relationship set between inputs, processes, outputs, outcomes, and targets by determining each previous factor the next one, is much simplifying of the fact, the method does not consider external dynamics.
<p><i>Consistent Performance Management System</i></p>	Flapper et al., 1996	The system which encompasses all performance dimensions associated with the existence of the organization as a whole, is meant by the method.	-	Relationships between performances indicators are defined, target values or value ranges for performance indicators are determined, and performance indicators are classified according to three specified characteristics.	The framework is required to be applied in different types of organizations in order to examine the general usefulness of it.

Table 15: Performance measurement frameworks/models at the 1991-2000 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<i>Integrated Dynamic Performance Measurement System</i>	Ghalayini et al., 1997	The system focuses on improving the competitiveness of manufacturing by overcoming limitations of existing performance measurement systems and motivating continuous improvement.	Customer satisfaction, compliance with customers, quality, delivery, manufacturing cycle time, cost of non-value added activities, process technology, education and training	The method takes precaution against sub-optimization, combines financial measures with operational performance measures by determining specific success areas, provides some critical performance measures which provide savings in terms of time, money and labor to three main areas of the company, success areas, performance measures and performance standards are dynamically updated by means of the method.	The method is extensively for manufacturing-based companies and the generalized application of the method is not discussed.
<i>Shareholder Value</i> (These references are used for the method: Rappaport, 1998; Bishop, 2009)	Rappaport, 1998	The method tries to maximize shareholder value.	Sales growth, cash profit margin, cash tax rate, working capital, capital expenditure, the risk-adjusted inflation, weighted average cost of capital and the time scale in which competitive advantage period is assessed.	The method provides principles to enterprises for creating value to their shareholders.	The method ignores other stakeholders of an enterprise such as employees, suppliers and customers.

Table 16: Performance measurement frameworks/models at the 1991-2000 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<i>Dynamic Performance Measurement Systems Model</i>	Bititci et al., 2000	A self-auditing dynamic performance measurement system is developed with the use of information technologies-based management tools	-	Different from the full life cycle of performance measurement, it tackles the review mechanism, extends the model control cycle and is dynamic.	In the literature, the more common application of this framework is not emphasized, while the logic behind the review mechanism used in the model is shown with a simple scenario there is an important information gap to deal with more complex scenarios.
<i>Integrated Performance Measurement Framework</i>	Medori and Steeple, 2000	The method is developed to control and improve performance measurement systems.	Quality, cost, flexibility, time, delivery, future growth	The framework can be used without any external consultation, it's proved that the method develops existing measurement systems to improve competitive advantage.	In the second phase of the method the difficulties are found in correlating a company's strategy and the six competitive priorities of the performance measurement grid; because performance measurement is a dynamic process, document B may require to be updated as it may go out of fashion in time; the dimension which is based on too little competition for designing the performance measurement system is considered.

Table 17: Performance measurement frameworks/models at the 1991-2000 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<i>Quantitative Model for Performance Measurement System</i>	Suwignjo et al., 2000	Identification of factors affecting performance and their relationships, hierarchical structuring of factors, use of <i>quantitative</i> models to measure the effects of factors on performance.	Cost per production unit (overhead, operating, total)	The effects of multi-dimensional factors on performance can be gathered in a single dimensionless unit.	As the method uses subjective measurement, the results may not be very accurate, the model has a period of use and it's valid only if the internal and external environment remains steady.

Table 18: Performance measurement frameworks/models at the 2001-2010 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<p>Action-Profit Linkage Model</p> <p>(These references are used for the method: Westbrook, 2000; Epstein and Westbrook, 2001; Taticchi and Balachandran, 2008; Epstein et al., 2000)</p>	Epstein and Westbrook, 2001	The model defines measures and comments causal relationships between firm activities and corporate profitability.	Company actions, delivered product/service, customer actions, economic impact	The model concentrates on the specific actions of the company and their impact on employees, customers and finally on the corporate profitability, encourages the investment-based approach to manage trade-offs in decision-making, companies can adapt the model to many business situations and the model doesn't depend any specific data-collection or forecast procedure.	The proposed framework is only a starting point for exploring the relationships between key performance measures and therefore it's needed to arrange according to the job specifications of the company.
<p>Performance Prism</p> <p>(These references are used for the method: Neely et al., 2007; Bourne et al., 2003)</p>	Neely et al., 2001	The method adopts the stakeholder-focused view of performance measurement.	Stakeholder satisfaction, stakeholder contribution, strategies, processes, capabilities	As regards stakeholders, the method makes an important distinction between stakeholder satisfaction and stakeholder contribution; the method considers other stakeholder groups such as regulators, legislators and interest groups in addition to traditional stakeholders; the framework is so comprehensive and multi-dimensional which enables all measures to be planned over it.	There is little guidance as to how performance measures will be implemented and almost never assessment relating to the use of the frame for the existing performance measurement system has been made.

Table 19: Performance measurement frameworks/models at the 2001-2010 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<i>Kanji's Business Scorecard</i>	Kanji and Sá, 2002	The method was developed taking into account the possibilities and limitations of the traditional Balanced Scorecard.	Organizational values, process excellence, organizational learning and delight the stakeholders	The method is not only a conceptual model but also a measurement, it determines the mutual relations between performance measures through structural equation modeling, the method takes into account more stakeholders compared to the Balanced Scorecard.	The method mostly focuses on external stakeholders.
<i>Beyond Budgeting</i>	Hope and Fraser, 2003	The method provides companies an alternative, compatible management model which enables to manage performance via especially adapted processes to present-day unstable market.	-	The method principles can create a set of adaptive management process as well as proposing a new, easy-to-understand management model and transfers power and decision-making authority from the center of the organization to employees.	The main emphasis in the model is on shareholders, other stakeholders are not adequately addressed.

Table 20: Performance measurement frameworks/ models at the 2001-2010 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<i>Dynamic Multi-Dimensional Performance Framework</i>	Maltz et al., 2003	Balanced Scorecard and Success Dimensions models provide a basis for the proposed model and to be added People Development as a separate performance dimension, is the main differentiator of the model.	Financial, market, process, people and future	The model is multidimensional inherently, it sees success as a dynamic, ongoing concept which is assessed at various time periods, represents many stakeholders, and the People Development dimension differentiates the model.	The application of the framework is not addressed adequately.
<i>Performance Planning Value Chain</i>	Neely and Jarrar, 2004	The method provides a systematic process for collecting a wide range of tools to use data to improve decision-making and derive value from it, and focuses on the effort to add real value to the organization.	-	The method provides a process for converting data to high-quality, value-added information which enables users to make more effective decisions.	The method is given only as a concept and experimental validation of it isn't shown.

Table 21: Performance measurement frameworks/models at the 2001-2010 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<i>Holistic Scorecard</i>	Sureshchandar and Leisten, 2005	The method is a conceptual, theoretical framework developed for performance management in the software industry.	Financial, customer, business process, intellectual capital, employee and social perspectives	The proposed framework adds new perspectives to more holistically describe all dimensions of enterprise performance, also restructures existing perspectives to add more clarity to the topics addressed.	Causal relationships between different perspectives in the framework have not been explained, more experimental works have to be done to ensure the reliability and validity of the proposed measures, the generality of the framework has not been discussed.
<i>Total Performance Scorecard</i>	Rampersad, 2005	The model emphasizes the need and importance of combining the company's goals and desires with goals and desires of the individual to develop an organizational structure and philosophy.	Financial, customer, internal processes, knowledge & learning perspectives, process improvement, personal improvement	The method combines PDCA cycle, talent development cycle and Kolb's learning cycle with personal and organizational Balanced Scorecard.	The insights are established from experience and experimental validation isn't presented.

Table 22: Performance measurement frameworks/models at the 2001-2010 period taking into consideration the Industry 3.0.

<i>Name of the Model/Framework</i>	<i>Author(s) and Year</i>	<i>Feature(s) of the Model/Framework</i>	<i>Dimensions of the Performance Measures</i>	<i>Advantage(s)</i>	<i>Disadvantage(s)</i>
<i>Holistic Performance Management Framework</i>	Andersen et al., 2006	The model is an integrated framework for holistic performance management.	Stakeholders, market, supply chain management, value creation	The framework contains the different areas which be needed to act in unison and supports each other in order to completely bring into force an organization.	The framework is developed on a pilot study basis but should be seen as a test that should be further tested in other types of industries / organizations in order to verify its validity on a wider basis.
<i>Flexible Strategy Game-Card</i> (These references are used for the method: Yadav and Sagar, 2011; Yadav, 2014)	Sushil, 2010	It is an integrated and holistic framework for strategic performance management and considers performance from two perspectives which are the corporate point of view and the customer point of view.	Situation, actors, process, performance, value in offerings and relationships	The dynamic nature of the framework, the holistic viewpoint and duality viewpoint help it to be considered as a holistic framework in performance management for the enterprise.	Both experimental and case study are necessary to confirm and interpret this new performance management framework for a variety of conditions.

As can be seen from the methods described above, enterprise performance evaluation methods gained momentum in the Industry 3.0 period and the methods have adopted in practice were developed in this period.

Analysis between Revolutions

Associated with the industrial revolutions, transformations have been experienced in the energy regime, transportation and communication tools as well as production processes have also progressed. All these developments have deeply affected the social, cultural and economic lives of the societies in which the revolutions took place. The developments brought by the industrial revolutions have enabled mankind to make great progresses, but the troubles that these developments brought with them later, have directed humanity to new quests and have provided to take place the subsequent revolutions. In other words, all events in the industrial revolutions have triggered each other.

In the middle of the 15th century with the invention of the most primitive printing machine by Johannes Gutenberg and his colleagues, the bible was began to publish. In the Europe with the spread of published bibles and other books, the Europe began to experience the Age of Enlightenment (Clark and Cooke, 2015). The Industry 1.0, whose infrastructure was formed in the Age of Enlightenment, began in 1788 with the invention of steam engine. The main energy source used in this revolution was coal. Due to the invention of steam engines and the intensive use of coal and iron, great progresses have been made in maritime and rail transports. Factories which could be called as the first modern commercial enterprises of that period were established and for this reason a lot of people migrated from the villages to the cities due to employment opportunities. Therefore, labor costs remained at a low level for many years. The increase in the sales of British products led to capital stock. The telegraph, which was invented and continued its development in this period, was the means for communicating in this revolution.

The production problems arising from iron which were used extensively in the Industry 1.0, caused the invention of steel and this event led to the start of the Industry 2.0. Although many studies have been done on it before, lighting up the dark nights of electricity that the discovery and use of it fall on this period, has affected the social life deeply. Because oil was discovered in this period, oil was also used extensively in addition to coal as an energy source. Factories continued to grow and the population of cities increased gradually. One of the greatest inventions of this period was the development of cars working with petroleum derivatives with the discovery of oil. Due to the invention of steel, railroad transportation continued to progress also in this period. As a result of these, highways have been used very extensively and have shown great improvement. Communication tools such as

telephone and radio are also the innovations of this period. Thanks to the advances in transportation the relocation of people has become easier and information exchange between people with the developments in the communication tools, has increased. In this way, people's ability about questioning has increased and this has led to new discoveries.

The oil crisis in 1973, which is seen by some as the beginning of the Industry 3.0, increased the search for new energy sources of the industrialized countries and natural gas became the most important energy source of this revolution. However, since coal, oil and natural gas are non-renewable energy sources, scientists continued to search for energy sources and nuclear energy was discovered in this period. The first computer which is called as ENIAC, was developed to meet the automation needs of the army during the Second World War. Fighter aircrafts used during the Second World War also enabled the development of aircraft technologies. In this way, humanity met with the airline transport for the first time. As a result of the researches carried out in order to provide the communication between long distances frequently and easily, the internet which can be considered as the most important communication tool of all-time, was found. With the invention of Internet, information has spread more than ever, and the borders between countries have completely disappeared. In this period, new production philosophies were developed to increase productivity in production. In addition, the depletion of fossil fuels and their damages to the environment have directed humanity to renewable energy sources and the concept of sustainability has appeared for the first time.

As a result, the social and economic events which took place before the revolutions have triggered the revolutions and the revolutions realized have affected the economic and social events of the period that they took place. In other words, there is a mutual interaction.

Conclusions

The industrial revolutions that emerged from the needs of human beings have influenced/changed/transformed the market dynamics, social dynamics etc. in the period when they occurred, or from a different point of view, market dynamics, social dynamics, etc. required the realization of industrial revolutions. As a result, many factors have been influenced by industrial revolutions in business and social life.

Therefore, the development of enterprise performance evaluation in this study has been examined in relation to the revolutions up to the Industry 4.0. The development of enterprise performance evaluation has been studied from the

beginning to the 2010 by the literature review method and has been historically divided according to the industrial revolutions. The trend of change in industry has also been sought in enterprise performance evaluation methods.

When the results are evaluated, the developments have taken place in the enterprise performance evaluation methods along with the Industry 1.0, Industry 2.0 and Industry 3.0. These developments have gained momentum especially in the Industry 3.0 and the most known and the most used methods in the field of enterprise performance evaluation have emerged in this period. Prior to the Industry 1.0, records were sufficient to monitor market prices, stocks, and record historical exchanges. With the Industry 1.0 which started with the invention of the steam engine, the enterprises that could be defined as the first modern enterprises of that time emerged and the production was mechanized. The factories in this period used double-sided cost calculations. After the discovery of electricity, which is one of the most important developments of the Industry 2.0, mass production started. Thus, the existing methods for developing and growing enterprises were insufficient and almost all techniques of modern accounting, DuPont and Tableau De Bord were developed during this period. With the invention of the computers, one of the most important developments of the Industry 3.0, the period of automation at the production began. Because the structure of the enterprises changed significantly, the most important developments in the field of enterprise performance management were experienced in this period.

Enterprise performance evaluation is the real-life problem which is multi-criteria, complex and has uncertainties. Optimal results may be obtained by using artificial intelligence techniques in real-life problems. In this context, it is expected to be used the artificial intelligence techniques which form basis of the Industry 4.0, in the future studies at the field of enterprise performance management.

Managerial Implications

Enterprise performance has always a significant impact on the activities of companies. Ways and tools to accurately measure performance have become an increasingly important field of research for both organizations and academics (Folan and Browne, 2005). However, in practice, we know that there are many companies that see enterprise performance equivalent to human resources performance and do not carry enterprise performance one step further. In fact, enterprise performance management is such a critical issue for businesses; development tool, mathematics of strategy determination... In this context, the concept of enterprise performance management should be comprehended very well not only by academicians but also

by business executives who are implementer of it and the development process of enterprise performance management should be examined. Providing a conceptual recognition of managerial impacts of enterprise performance management and examining the relationship between industrial revolutions and enterprise performance management are targeted in this article.

With the start of industrialization and mass production, the need to manage the performance of the institutions emerged. At the same time, industrial revolutions created profound effects and changes in the productions and managements of enterprises. We can say that the maximum developments in enterprise performance evaluation methods were experienced with the 3rd Industrial Revolution and the managerial effects peaked in this period. Artificial intelligence has entered into all areas of life in the present period. With these developments, efforts to establish enterprise performance calculation and forecasting models continue. More realistic performance results can be obtained by including tools such as big data and internet of things in enterprise performance calculations. With these models, proactive managerial effect will occur in the enterprises.

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