
Management control, from traditional practice to the use of Artificial Intelligence

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Received: 23/12/2024

Accepted: 17/03/2025

Published: 04/06/2025

Abstract:

In the context of digital transformation, artificial intelligence now holds a central place in the strategy of organizations. It is involved in all functions of the enterprise, and management control does not seem to be spared. Research is beginning to question the evolution of the role of management control in this new environment. Management control is a system based on the collection and analysis of information with the aim of providing leaders with information to assist them in their strategic decision-making to achieve the company's desired objectives. The integration of artificial intelligence into this system offers significant benefits such as automating repetitive tasks, optimizing decision-making processes, and quickly identifying trends. The goal of this research is to study the growing influence of artificial intelligence on the management control function and the role of the controller. It examines how emerging technologies such as big data and predictive analysis transform traditional management control processes.

Keywords: Management control; Artificial Intelligence; Big data; Business partner; decision-making.

Jel Classification Codes : M150, M190, O32.

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1. Introduction:

It is meant by a management control system a process for collecting and using information. Besides, it contributes to the implementation and coordination of forecasts and decision-making in the various sections of the organisation. In virtue of which, the aim of this system is to improve decision-making within the organisation (Horngren, Bhimani, & Datar, 2009). More to the point, the management control system is increasingly subject to an obligation to attain results, a need for globalisation of the organisation and a real-time approach. As a result of various crises, flexibility constraints, advances in flow management and a better understanding of the costs of quality and the impact thereof on the value delivered to customers, it has been enriched with tools that can replace its traditional ones (Dumas & Larue, 2012). Nevertheless, new tools have been introduced with the development of information and communication technologies, as Artificial Intelligence (AI) has shown to be one of these tools.

The concept of AI is not new. Alan Turing, a British mathematician, was one of the first to take an interest in AI with his article entitled as "Computing Machinery and Intelligence" in 1950. At that time, he was wondering about the ability of thinking machines. Further, the concept became more concrete five years later thanks to the work of the Dartmouth Conference (*Dartmouth Summer Research Project on Artificial Intelligence*), a scientific workshop organised in 1956 on the theme of Artificial Intelligence, which is considered to be the birth certificate of artificial intelligence. Nonetheless, organised by Marvin Minsky and John McCarthy, the conference brought together twenty researchers, including Herbert Simon, an American economist, sociologist and psychologist; Allen Newell, a scientist at the RAND Corporation studying logistics and organisational theory, and John Clifford Shaw, a computer programmer at the RAND Corporation.

At this conference, Allen Newell, John Clifford Shaw and Herbert Simon presented the "*Logic theorist*", the first programme created to reproduce human problem-solving abilities. Likewise, it was the first time the term "Artificial Intelligence" was used (IAROCCI, 2021). After this promising conference, research into artificial intelligence continued to develop.

A priori, AI consists of making an intelligent artificial system, essentially a computer. In this respect, computers are programmed to imitate human behaviour by exploiting massive quantities of data, using programmes based on algorithms.

The AI field of application is very vast and currently affects practically all areas. In this work, we shed light on the field of management and more specifically on management control. The aim of this study is to analyse the impact of AI on the management control function, exploring the opportunities and challenges it presents to organizations. The study attempts to explain how AI-based tools can improve data collection, processing and

analysis, optimize decision-making and strengthen business performance. Further, our objective is alike to analyse the evolution of the role of the management controller in organisations with the arrival of AI tools.

For the purpose of answering our problem, we first present a literature review on the fundamental concepts related to management control and AI. Then, we focus our analysis on the use of AI tools in the field of organisational management, together with the impact thereof on the management control function.

2. Literature review

2.1. Presentation of the traditional concept of management control

Indeed, management is a science of action that applies to any organisation or economic entity in the commercial sector (industrial or commercial companies) or the non-commercial sector (government departments, non-profit associations) so as enable the same for attainment of its strategic objectives. Besides, an organisation is efficient should it know how to obtain its resources and means at the lowest cost and in line with its objectives.

Moreover, control means being able to master a situation and direct it in the desired direction. Thus, the aim of any control is to measure the results of an action and to compare such results with the objectives set beforehand to determine whether there is agreement or divergence. As consequence, control must lead, needed it does, to a return upstream to rectify the decisions and actions taken. (ALAZARD & SEPARI, 2010).

Management does not just note the attained results, it analyses them and proposes concrete improvements; for such purpose, it relies on forecasts, anticipations and a control system that helps decision-makers to ensure that results are in line with objectives, hence the objective of management control.

The management control function emerged in the USA after the 1929 crisis, at a time when industry was booming. Hence, the aim was to provide a forward-looking vision of the company's activity based on management indicators (Lima & Giney, 2022).

In fact, Management control continued to develop in American companies until the creation of the Controllers Institute of America in 1931, which was the first institute for management controllers. Nevertheless, it was only the Second World War that this discipline made significant progress. Thus, the need to set up a management control function within a company was a corollary of the development of large American companies, in respect such as General Motors and du Pont de Nemours. The size of these companies meant that they could no longer be controlled directly by the management, and this new function was born out of the need for control by the managers of these large organisations. (Rongé & Cerrada, 2012).

In fact, the management control has been defined as "the process by which company managers ensure that resources are effectively and efficiently used to attain the outlined objectives" (P.H., DOBLER P, MENDOZA, & NAULLEAU, 1991). Besides, H. BOUQUIN gives a simple and complete definition: "Management control refers

Management control, from traditional practice to the use of Artificial Intelligence

to the systems and processes which guarantee consistency between strategy and concrete, day-to-day actions". (BOUQUIN, 1994).

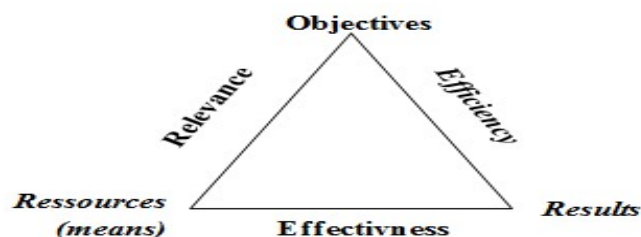
According to R.N. Anthony, who first theorised the academic discipline of management control, "Management control stands for a process by which managers ensure that resources are obtained and effectively and efficiently used to attain the organisation's outlined objectives". (R.N., 1965)

In 1982, the General Chart of Accounts took up this analysis and defined management control as "all the measures taken in order to provide managers and other persons responsible periodic data on the company's performance. Further, their comparison with past or forecast data may, if necessary, prompt management to take appropriate corrective action" (ALAZARD & SEPARI, 2010).

All the definitions emphasise three essential components of management control:

- **Process:** Management control is not an isolated action but a process. A process is a succession of operations from the development to the supply of a specific product or service. It is the set of actions implemented to transform input elements into output elements.
- **Resources:** Management control enables managers to ensure that resources (raw materials, information, material assets, equipment, financial resources) are obtained and used effectively and efficiently.
- **Effectiveness:** It stands for the ratio between the planned objective and the real achievements, without taking into account resources (time, money, stress, ...). Moreover, it is the achievement of objectives.
- **Efficiency:** It is the relationship between the result and the resources used to achieve this result at the lowest cost.
- **Relevance:** Relevance is the conformity of the means and actions implemented to attain a given objective. In other words, to be relevant is to effectively and efficiently attain the objective.

Figure 1: The management control triangle



Source: Loning et al, Management control, organization, tools and practices, 03rd Edition, DUNOD, 2008, page 6.

Management control is an information system designed to provide management with the information they need to make strategic decisions with a view to attaining the company's objectives. As its objectives are:

- Contribute to the definition of strategy and monitoring the implementation thereof;
- Assess performance through: Controlling, analysing and improving performance;
- Monitore activity and taking corrective action, analysing deviations and highlighting the reasons thereto;

- Prepare resource allocation in line with short-term and strategic objectives;
- Reconcile and link strategic management control with operational management control;
- Enable each manager to steer his/her management unit in order to forecast and programme resources and milestones, monitor performance and react, and also to enable each manager to illustrate the results he/she has attained, the decisions he/she has taken and the objective towards which he/she is heading;
- Ensure, in closing, that the company is appropriately managed.

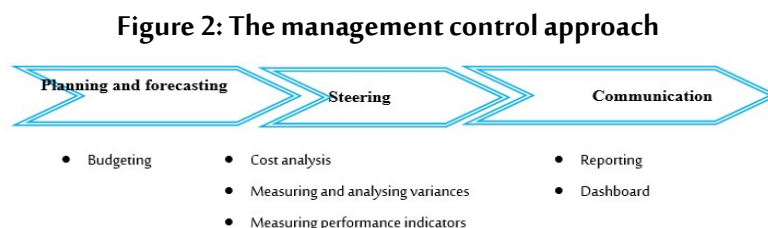
The management control process comprises various phases, in respect such as:

- **Planning:** The starting point of management control is planning, which consists of defining objectives and then translating them into operational actions through marketing, investment, human resources management and financial management policies.
- **Budgeting:** The budget phase begins with the setting of short-term objectives, which are derived from medium-term action plans. This phase is essentially concerned with defining, coordinating and approving the company's action plans, and implementing commercial, production, purchasing, human and financial resources by evaluating future results, checking the use of resources against the results plan, and modifying execution and action plans.
- **Action and follow-up of achievements:** The most important phase following budgeting is the one of taking action or implementing action plans, translating them into action to attain the outlined objective.
- **Measuring results:** The final phase consists of analysing the results in order to identify any corrective measures required.

To carry out his/her work, a management controller relies on data and information concerning the company. Besides, management control tools are used to collect, process and analyse this data and information. These tools fall into 03 categories:

- Planning and forecasting tools (budget management);
- Steering tools for assessing and analysing results (financial accounting, cost accounting and budgetary control);
- Communication tools (reporting and dashboards).

We have summarised this approach in the following diagram:



Source: by the author.

2.2. The role and missions of the management controller

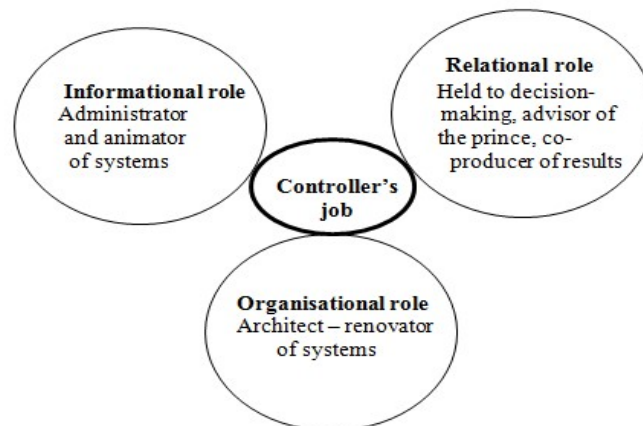
The role of the management controller is evolving as a function of management and its environment, broadening its scope (ALAZARD & SEPARI, 2010). Management control cannot be equated with is made by the management controllers. Although the management controller intervenes in the management control process, the latter belongs alike to the tasks of the managers, who negotiate their resources; commit to objectives to be outlined; take corrective decisions where necessary. (Benoît Gérard, Bénédicte, Yves Levant, & Farjaudon, 2018). Gérard and al (2018) mentioned three major roles of the management controller:

- Leading the management control process: This role involves producing, disseminating, processing and analysing information, particularly as part of the budget cycle;
- Supporting managers: This role involves assisting, helping or advising managers, and sometimes even co-leading their area of responsibility;
- Designing and adapting control systems: This role involves building, redesigning and rethinking processes and the organisation of information.

The roles of the “management controller” differ in relation to the assigned tasks, the degree of difficulty of the information in the function and the obligations of management.

As consequence, it is important for the controller to keep in mind the three dimensions of his/her job, to maintain his/her willingness to operate in all three and to perform all three roles. (Loning, et al., 2008).

Figure 3: The controller’s three roles



Source: H el ene Loning, V eronique Malleret, J er ome M eric, Yvon Pesqueux, Eve Chiapello, Daniel Michel, Andreu Sal e, Management control, organization, tools and practices, 03rd Edition, DUNOD, 2008, page 277.

The management controller’s job involves defining and analysing quantitative and qualitative data pertaining to the management of the company; the reason why they need to have the specific skills required to carry out their job. Further, they must be specialists (mastering tools), generalists (organising and coordinating procedures), operational (managing execution), functional (advising decision-makers), technical (integrating the

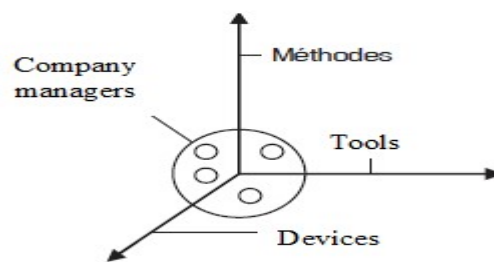
technical dimension) and human (managing people and groups). Moreover, their role is to transform figures and other data into clear, succinct summaries of information accompanied by analyses.

Bouin and Simon (2009) have listed the following tasks for the management controller:

- Clarifying, at all levels of the company, the growing complexity arising from globalisation, the acceleration of flows, the dematerialisation of exchanges, the exponential increase in the number of market segments, etc.;
- Constant organisational change;
- Helping the company's players to identify the risks of non-performance as well as the potential for progress, both through its knowledge of processes and activities and its problem-solving tools, which it will use to quantify and record savings in the income statement and balance sheet;
- Be the guarantor of reliable information in the processes of collecting, processing and reporting information at all levels of the company (Bouin & F-X Simon, 2009).

The management controller must be flexible and adaptable in order to provide people and organisations with visibility and responsiveness. For fulfilment purpose of their role, management controllers rely on both physical (meetings, steering committees, appointments, etc.) and digital (specific software, etc.) systems. Above and beyond, it is through such systems that the management controller uses a style that must constantly oscillate, with regards to the players, between a certain rigidity (to ensure compliance with the standards) and a certain benevolence and openness (to educate and create management dialogue). In virtue of which, the difficulty lies here in the management controller's interpersonal skills. (Cappelletti, Baron, Desmaison, & Ribiollet, 2014)

Figure 4: The Management control procedures



Source: Cappelletti, Baron, Desmaison, & Ribiollet, The entire management control function, DUNOD, 2014, page 11.

As in many professions, the Management Controller started out with Excel spreadsheets and software, but the emergence of digital and Artificial Intelligence together with the need to analyse a myriad of data have alike required more sophisticated tools. Since the mid-2010s, the world of the Financial Controller has undergone significant change, thanks to: -

- The emergence of the cloud, and hence the storage of huge quantities of data;
- The increase in the power of the machines that process such kind of data;
- The emergence of data consolidation and visualisation software. (WEB 1)

Indeed, Artificial Intelligence is now at the heart of organisational strategy, and is likely to radically transform the organisations' working way.

2.3 Fundamental concepts of Artificial Intelligence

Before addressing Artificial Intelligence, it is essential to first understand what intelligence is: the term intelligence comes from the Latin "Intelligentia", which means the faculty of understanding and linking elements to each other.

The theory of multiple intelligences, first proposed by Howard Gardner in 1983 (a Harvard professor working on children who were failing at school), lists nine forms of intelligence (Mathivet, 2014):

- **Logical-mathematical intelligence:** This is the ability to work with numbers, analyse situations and work out reasoning;
- **Visual-spatial intelligence:** This indicates the ability to represent an object or environment in 3D, and is used to follow a map, remember a route or imagine what a shape in space looks like from its plan;
- **Verbo-linguistic intelligence:** This is the ability to understand and express ideas using language. It requires a good knowledge and command of vocabulary;
- **Intrapersonal intelligence:** This is the ability to have a true image of oneself, which means being able to determine one's emotional state, desires, strengths and weaknesses;
- **Interpersonal intelligence:** This is the ability to understand others and react in appropriate way. Therefore, it is linked to the notion of empathy, tolerance and sociability;
- **Bodily/kinesthetic intelligence:** This is the ability to have a mental representation of his/her body in space and to be able to carry out a particular movement. Used extensively by athletes, it enables them to make the right gesture at the right time;
- **Naturalist intelligence:** This is the ability to sort, organise and prioritise the objects around us. Further, it enables us to define species and sub-species, or to construct classifications;
- **Musical intelligence:** The ability to recognise melodies, notes and harmonies or to create them;
- **Existential or spiritual intelligence:** The ability to ask questions about the meaning of life and our purpose.

Many tests have tried to measure intelligence, the best known being the I.Q. (Intelligence Quotient) test. Nevertheless, they have been heavily criticised for not being able to measure all forms of intelligence and for focusing mainly on logical-mathematical and visual-spatial intelligence. On the other hand, all other forms of intelligence are ignored.

Definitely, intelligence is the ability to use and manage knowledge to solve problems. Likewise, intelligence manifests itself in "decision making", the selection of the most appropriate solution for the problem in question (Frécon & Kazar, 2009).

Some forms of intelligence are not specific to humans but to machines. Thus, this stands for artificial intelligence.

There are many definitions of Artificial Intelligence, some of which are set out hereinafter:

The term “Artificial Intelligence” refers to the body of work centred on the use of software and/or hardware machines to carry out activities that are thought to require intelligence on the part of the humans who normally perform them (Pastre, 1988). Pastre adds: Artificial Intelligence is the science whose aim is to use a machine to perform tasks that humans accomplish using their intelligence (Pastre, 2000). In addition, Artificial Intelligence lies somewhere between Cognitive Psychology, from which it draws its inspiration in terms of aims, and computer science in terms of material resources.

Simply put, Artificial Intelligence is a system of machines and software, based on algorithms, designed to help humans in their daily lives. However, an algorithm is a sequence of ordered, well-defined operations that can be executed on a current computer, and which enables the solution to be reached in a reasonable time (minutes, hours, or more). (Laurière, 1987).

The National Science and Technology Council (2016) defined the goal of Artificial Intelligence as: “The long-term goal of general artificial intelligence is to create systems that exhibit the flexibility and versatility of human intelligence across a wide range of cognitive domains, inclusive of learning, language, perception, reasoning, creativity, and planning”. (Ventre, 2020)

Artificial Intelligence relies on both software (programming languages, applications) and physical components, hardware (sensors, robots, etc.) to process data and assist human decision-making.

A distinction is made between strong and weak intelligence:

- Strong A.I.: In the long term, it is intended to replace human intelligence and improve through self-learning;
- Weak A.I.: It is positioned more as an aid to decision-making and forecasting. It knows what can be made by humans. At present, it is widely used in technological objects and for the main customer relations applications, such as chatbots.

Every now and then, Artificial Intelligence limits its objective to interpreting a situation or a text. More often, it is a constructive activity, a function of a situation and an objective, of the “problem-solving” type (Frécon & Kazar, 2009):

- Synthesis problems, such as the design of an object, defined in terms of objectives and constraints;
- Planning problems, with a view to attaining an objective by combining in time various means of action subject to constraints;

- Diagnostic problems (medical, financial, technical, etc.) aimed at understanding the causes of a situation based on various symptoms, and defining how to remedy the situation (in terms of decision support or planning);
- Decision support problems, aimed at clarifying and determining choices based on a situation, objectives and constraints.

Other terms are often used in the context of Artificial Intelligence, in respect such as “machine learning”, “deep learning” and “big data”, as definition of each of these concepts is given hereunder.

❖ The Machine Learning

The Machine Learning is a branch of AI that is capable of reproducing behaviour using algorithms fed by a large amount of data. Confronted with numerous situations, the algorithm learns which decision to adopt and creates a model. The machine can automate tasks depending on the situation (WEB 2). A traditional computer programme performs a task by following precise instructions, and therefore systematically in the same way. In contrast, a *Machine Learning* system does not follow instructions, but learns from experience. As a result, its performance improves as the algorithm is exposed to more data (WEB 3).

❖ The Deep Learning

The Deep Learning is a sub-category of Machine Learning. It seeks to understand concepts with greater precision, by analysing data at a high level of abstraction, using non-linear understanding (WEB 2). Besides, it is based on various artificial neural networks. This is a function that processes data to imitate the human brain to enable machines to detect objects, recognise speech, translate languages and much more (WEB 4).

❖ The Big Data

The National Science Foundation defines Big Data as “voluminous, diverse, complex, longitudinal, and/or distributed data sets generated from instruments, sensors, Internet transactions, emails, videos, click streams, and/or any other digital sources available today and in the future”. Big Data or mega data corresponds to massive quantities of data generated by several sources. After pre-processing (formatting, conversion, filtering), Big Data is analysed using complex algorithms to identify and classify the same automatically, without human intervention (WEB 6). On the other hand, several generations of Big Data representation models have successively emerged, the best known being the 3V model: Volume (data scale), Speed (continuous data analysis), Variety (different forms of data). The 4V model adds veracity (data uncertainty) to the previous three characteristics. Other Vs (for example, value, which associates a financial cost with information) have alike appeared (WEB 6).

Artificial Intelligence is a vast field, now affecting a number of sectors: transport, health, education, energy, tourism, finance, commerce and management. Likewise, its development is having an impact on the organisation

of work, which can be made easier (operator assistance for arduous tasks; for example, automation of repetitive tasks).

3. Artificial Intelligence at the service of business management

Digital transformation, digitalisation and the advance of robotics are taking hold in businesses, and companies are becoming increasingly digital. Further, a digital company is one that has incorporated the use of innovative digital tools into its day-to-day operations, in respect such as Big Data, Artificial Intelligence, dematerialised IT systems, social networks and the Internet of Things (Cavelius, Endenich, & Zicari, 2018). In this respect, this progress has revolutionised the way work is organised within companies, refocusing human activities on tasks with higher added value. The performance of the most arduous tasks by collaborative robots shall alike lead to the creation of new jobs for the design, maintenance and operation of these intelligent robots. Moreover, the companies that equip themselves with them will gain in competitiveness, and will be able to develop new skills (WEB 7).

The AI has not only changed the way companies work, it has affected virtually every function in the organisation, including management, human resources, accounting and auditing, purchasing, production, marketing, and the like.

Beyond doubt, Artificial Intelligence is becoming involved in management. According to experts, AI will be able to handle a range of management tasks that until now have only been carried out by humans. (Dejoux, 2020) explains in his book that there are tasks that can be completely performed by AI. Further, AI is proving very useful because it is much faster than humans, with less risk of error. It saves precious time. These AI-automated managerial tasks can include filing files, creating websites, providing answers via database searches, setting up alert systems and predicting sales. More and more, it assists the manager, without replacing his/her ability to make the final decision (Dejoux, 2020). AI supports decision-making, or even replaces it.

For human resources, AI is capable of exploring a massive amount of data that is difficult for human beings to grasp. In the administrative and legal aspects of the human resources function, many administrative and legal supports are using AI (virtual assistants, chatbots) to provide automated answers, in real time and from any location, to questions asked by employees. Likewise, AI is being used to deal with global issues, in respect such as absence management, leave requests, payroll and salary policy and requests relating to the regulatory aspects of human resources management (CHEVALIER & DEJOUX, 2021), as well as to help with recruitment and the definition of appropriate training programmes for employees.

Thanks to AI and the development of technologies, the accounting and auditing professions are undergoing their greatest transformation.

Management control, from traditional practice to the use of Artificial Intelligence

Before AI, accountants processed invoices, purchase orders and delivery notes manually, on paper. All these documents were then manually entered into the IT systems, allocated, then sent to the relevant managers via initials (filled with paper...) or Excel spreadsheets, for approval and payment. Nowadays, with AI, each manual step in the process is replaced by an automatic function that analyses, recognises and automatically integrates the data into the information system. At the end of the chain, suppliers who “before” had to be patient to find out when they would be paid, “now” have real-time information (WEB 8). Accounting systems and operations have moved from paper and ledgers to digital formats with the use of computers and expert systems (Lin & Hazelbaker, 2019). According to estimates, robotics and automation have eliminated around 40% of the work that accounting professionals used to do (Kaya, 2019). Indeed, intelligent systems are currently used to carry out inventories, manage bank audit confirmations, read contracts or other documents to generate relevant information, plan the audit, evaluate evidence, analyse specific accounts or produce audit reports (Lin & Hazelbaker, 2019). With the advent of AI, accounting professionals will not be completely replaced by machines. On the contrary, their responsibilities and contributions within organisations will evolve in a positive way (Jacob, Souissi, & Trudel, 2020). The automation of processes and the use of AI technologies in the accounting sector have many advantages. In this respect, they help to free employees from routine and time-consuming tasks performed manually. However, saving time allows them to focus on value-added activities, which are based on strategic thinking and decision-making (Meskovic, Garrison, M., Ghezal, S., & Chen, Y., 2018).

Marketing and sales functions already embraced AI a few years ago. Advances in AI mean that massive amounts of customer data can be collected and analysed much more efficiently and accurately than ever before. Nonetheless, this increased ability to collect and analyse data allows businesses to better understand their customers’ needs and preferences. Likewise, AI marketing technologies enable companies to better measure the impact of their marketing campaigns and optimise their marketing efforts in real time (WEB 9). Relationship marketing relies on the use of deep learning technologies to optimise the understanding of publications on social networks (Hatchuel & Filet, 2020).

The development of AI has changed the job of the management controller, who is faced with new playgrounds for understanding company performance. The possibility of exploiting data via AI algorithms and programmes opens up a new paradigm for management and management control technologies and practices (MOINARD & BERLAND, 2020). In this respect, we illustrate the role of management control in this era of change in the following section.

Lemercier (2023) has specified that the impact of Artificial Intelligence on the way companies operate depends on the place it can be given within the decision-making process. There are currently three distinct forms of Artificial Intelligence. In the first form, Artificial Intelligence assists humans in their decision-making, with

machines carrying out certain specific tasks. In the second form, humans and machines share decision-making rights. And in the third form, decision-making is the sole responsibility of the machine. Depending on how decisions are shared between humans and machines, Artificial Intelligence is assisted, augmented or autonomous (Lemercier, 2023).

4. The impact of Artificial Intelligence on the management control function

4.1. Towards the automation of management control processes

The role of the management controller is to help managers better understand and steer the company's performance. In this sense, they act as co-pilots, business partners, facilitators and coaches for progress and change (Bouin & F-X Simon,, 2009). His mission is based around 2 axes:

- Provider of reliable data;
- The manager's *business partner* or co-pilot.

The emergence of AI and the development of new technological tools used in business management have led to the transformation and optimisation of the procedures adopted by the management controller. As in many professions, the management controller started out with Excel spreadsheets, but the emergence of data and the need to analyse a myriad of data has alike required more sophisticated tools.

The arrival of technology and digital transformation has transformed the way businesses operate. Thus, management control has had to adapt to these changes.

As a data provider, the management controller must provide and process reliable and relevant information to help managers make management decisions. As digitalisation improves the availability of data and automates a number of processes in information systems, the role of the management controller as a provider of information is likely to diminish in favour of the role of adviser to the manager (Cavelius, Edenich, & Zicari, 2018).

Automating information system processes involves replacing manual tasks with tools or software to make work easier. The aim is to reduce human error and optimise operational efficiency. Data management is part of this robotisation. Further, data is collected from different sources, then automatically analysed by software. This saves time and increases productivity. The integration of applications used by the company, in respect such as the human resources management system, customer relationship management, supply chain management, etc., reduces repetitive manual data entry and improves overall efficiency (WEB 10). These tools can provide the manager directly and automatically with all the information he/she needs, reducing the management controller's tasks and limiting his/her role to that of adviser or co-pilot.

Automating management control processes means using systems to collect, process and analyse a company's financial and operational data. Several automation tools have been developed (WEB 10):

- Integrated management systems, including accounting, stock management and human resources software, to bring all the data together;
- Automated dashboards and reports to make it easier to analyse and understand the company's financial and operational data in real time;
- Implementation of planning and budgeting processes.

4.2. Enterprise Resource Planning (ERP) systems

With the development of computer technologies in the 1970s and 1980s, production planning systems (MRP) were developed. These are software programmes that enable better production planning, a reduction in stocks and a reduction in waste (scrap). In 1990, concepts similar to MRP were developed to manage business activities other than production, namely finance, customer relationship management and human resources. Besides, Technology analysts gave this new category of business management a name: ERP (Enterprise Resource Planning) (WEB 11).

The ERP is a software package that manages all a company's operational processes by integrating several management functions: order management, stock management, payroll and human resources management, accounting and financial management, supplier management, distribution and sales management, e-commerce management, etc. into a single system. Moreover, ERP uses a single database to store all the company's information, enabling better collaboration between functions and greater visibility of the company's activities. Above and beyond, the ERP is an integrated management system that brings together several applications to manage a company's operational and administrative activities. It works by linking a company's various departments and providing a unified view of all the company's information.

There are several stages in the operation of an ERP system:

- **Data collection:** Data is collected from various systems and sources to be centralised in the ERP system;
- **Data storage:** The data collected is stored in a centralised database, which can be accessed by all the company's departments;
- **Data processing:** The data is processed so that it can be used by the company's various departments;
- **Data analysis:** Data is analysed to help decision-makers make informed decisions;
- **Reporting:** Reports can be generated from the data collected to help decision-makers understand the company's performance.

Users can access the data and functions they need for their work at any time, which can improve productivity and collaboration between departments (WEB 12).

Figure 5: General diagram of an ERP system



Source: <https://www.projectline.ca/blog/what-is-erp-enterprise-resource-planning>

In organisational terms, the introduction of ERP systems is seen as a change in the information system and in the steering and control process (GOMEZ, FROT , & DUWER, 2002). Besides, decision-makers have a cross-functional, global but alike highly accurate view of information flows, enabling them to refine and accelerate decision-making.

More to the point, ERP systems are an invaluable aid to management controllers in their role as data providers. Meyssonier and Pourtier (2006) confirm that they are a formidable tool at the service of management controllers, who have erased the constraints of collecting and storing information, by enabling it to be updated rapidly, automatically producing monitoring reports (dashboards) and speeding up feedback procedures (Meyssonier & Pourtier , 2006). The management controller spends less time collecting data, has easier access to internal and external information and gains more time for interpretation and advice.

Numerous studies have highlighted the positive impact of ERP systems on management control practices. In virtue of which, the main findings of these studies pertain to the modernisation of practices, the optimisation of information processing and the performance of reporting, which is essential for decision-making. Nevertheless, other research reveals that ERP systems have brought about relatively minor changes in management control and internal control. In most cases, advanced management control techniques such as ABC, as well as many traditional methods, are performed in separate systems. With regards to costing and profitability, the results indicate that some companies have integrated their practices into the ERP environment (Yassine & RIGAR, 2019).

4.3. From ERP to Big Data

In recent years, AI and the development of big data have provided management controllers with new playgrounds for understanding company performance. Besides, the possibility of exploiting this data via AI algorithms and programmes opens up a new paradigm for management and management control technologies and practices (MOINARD & BERLAND, 2020).

Management control, from traditional practice to the use of Artificial Intelligence

In addition, management control is an approach that enables a company to produce economic and financial indicators, generally expressed in terms of “performance”. This approach requires a large amount of data to be processed. The massive and digital dimension of this financial data and the degree of complexity has made Big Data an indispensable tool for guaranteeing efficient management of companies and a major lever for improving their performance (Boutgayout & El Ghazali, 2020).

Collecting a large amount of data is not enough to be economically exploited. Likewise, the management controller needs to analyse and cross-reference the data in order to extract information. Here again, artificial intelligence facilitates these data processing operations (Dejean-Ozanne, 2022).

Big Data enables the management controller to cross-reference internal ERP data relating, for example, to sales and customers, with external data such as the customer satisfaction rate (information gathered from social networks) to identify correlations between sales’ volumes and the quality of the product sold, in order to make decisions on whether or not to continue marketing. In this case, the algorithm produces correlations where the decision-maker needs causalities (MOINARD & BERLAND, 2020).

(Boutgayout & El Ghazali, 2020) add that with Big Data, it is even possible to carry out analyses and forecasts for future periods using predictive analysis tools, thus saving a considerable amount of time and effort when drawing up budgets.

In this respect, a number of tools are available for this purpose: Enterprise Performance Management² (EPM) tools, which report on actual performance, draw up budgets and analyse variances; and *Business Intelligence* (BI) tools, which extract and display data and build dynamic dashboards. Moreover, the most advanced EPM and *Business Intelligence*³ solutions already offer advanced functionalities (Hatchuel & Filet, 2020):

- High-quality data and repositories;
- Modelling and simulation of revenues and costs using automatically detected drivers: number of series manufactured, number of orders placed, number of deliveries, number of customers, etc;
- The implementation of automated controls to guarantee the consistency of the forecasting model.

²The EPM stands for software designed to help companies plan, budget, forecast and report on business performance, as well as consolidate and finalise financial results. Likewise, EPM software complements ERP systems by providing management information in addition to operational data. In other words, ERP is about running the business, i.e. the day-to-day transactional activity, and EPM is about managing the business: analysing, understanding and reporting on the business. (<https://www.oracle.com/fr/performance-management/what-is-epm/>).

³The Business Intelligence (BI) is defined as “the technology that facilitates the collection of data, its analysis and the transmission of information, and that puts it into a form that supports decision-making” (Rikhardsson and Yigitbasioglu 2018, p. 37). Further, BI makes it possible to create reports with data visualisations that greatly facilitate their understanding and analysis both by the management controller and by other members of the organisation (Reutter, Allain, & Landagaray, 2021).

In fact, such practices have changed the role of the management controller, who has become a genuine business partner on a virtually full-time basis, devoting his/her time to advising and supporting the organization's managers in their decision-making.

4.4. Impact on the management controller's job

In the face of the growing phenomenon of Big Data, the management controller finds himself spending a great deal of time feeding algorithms with a mass of data, analysing correlations and understanding the interactions between the data, all of which makes decision-making more complex. Above and beyond, the decision-maker finds himself caught up in a double contradiction (MOINARD & BERLAND, 2020):

- Increasing the volume and nature of data to ensure the quality of prediction systems;
- Simplify and reduce the data, and make the decision-making exercise acceptable to the timeframe of the action.

(Cavelius, Endenich, & Zicari, 2020) believe that the digital age brings with it the danger that management controllers will increasingly have to engage in tasks that are more those of a technician than those of a business partner.

The management controller has done away with the tedious aspects of collecting and putting the data in order, and has become the expert in interpretation, alongside a data analyst who produces the figures in interface with the algorithms (MOINARD & BERLAND, 2020). According to (Zaidi, 2021), the growth in the volume of data makes it harder to read and more difficult to make operational decisions. Management controllers run the risk of making erroneous interpretations and reaching false conclusions (A.S., Perray-Redslob, & Langevin, 2018).

We conclude this work with the results of two surveys. The first was conducted in 2016 by the International Management Control Observatory on the processes, methods and tools of management controllers in the age of digital transformation. The survey covered companies in all business sectors in 38 countries. The results of the survey show that the main objectives of using Big Data for management controllers are (WEB 14):

- Improve analytical capacity (actual / planned): 79%;
- Adapt the business model to market changes: 63%;
- Optimise processes and costs: 55%;
- Improve the company's financial results: 54%;
- Seek growth opportunities: 52%;
- Enable the company to adapt to its market: 46%;
- Adapt products/services to market needs: 46%;
- Activate the fight against fraud: 30%;
- Align organisational structures: 20%.

According to the results of this study, improving analytical capabilities is the primary objective of management controllers when it comes to using AI in their business, in order to facilitate decision-making.

The second survey we are presenting is an Axys Consultants survey on AI and management control, conducted among the finance and management control departments of large companies and mid-sized businesses. More than 2,000 employees were asked about the benefits of AI for the management control function, and the survey came to the following conclusions (WEB 13):

- AI seen as an “undeniable” opportunity to improve operational efficiency and decision-making:

According to respondents, the main benefits of AI would be to “assist” management controllers in execution and decision-making, as well as to “increase” human analytical capabilities. Other respondents cite as added value the improvement of the function’s operational efficiency, the acceleration of decision-making and the ability to make forward-looking approaches simpler.

- Technical skills, the main obstacle: According to respondents, the biggest obstacle is technical skills. Besides, the financial managers would be prepared to launch an AI experiment on budget modelling if ready-to-use solutions existed, even though the main publishers on the EPM market already offer packaged solutions incorporating AI modules applied to management control (simulation of revenues, costs, staff and payroll, etc.).

- The impact of AI on changing management culture is still poorly understood: A minority of respondents spontaneously mention AI as a vector for “change in management culture”. And yet, freed from the tedious tasks of collecting and processing data, the management controller is likely to become a specialist in data analysis and modelling. Further, implementing an AI approach within the Management Control function implies a positive transformation of the role of the management controller, a role that is “augmented”, i.e. freer to exercise their capacity for analysis and decision-making.

Indeed, AI is a veritable revolution for management control, since its effectiveness depends on the information it receives. In this respect, the controller will be responsible for providing it with reliable data, management rules, explanations and logical reasoning specific to the company, which will develop its capacity for analysis. As consequence, management controllers need for development purpose of new skills to better support these changes.

5. Conclusion

Artificial intelligence is revolutionizing the field of management control by offering remarkable analytical and predictive capabilities. Further, with AI, companies can harness sophisticated algorithms to analyze huge data sets from a variety of sources. Hence, this enables a deeper understanding of trends, patterns and behaviours, providing controllers and managers with a clearer and more accurate view of business performance.

The results of the studies studied in this work have shown that improving analysis capabilities constitutes the main objective of management controllers regarding the use of AI in their profession, in order to facilitate decision-making.

Moreover, AI has freed the management controller from tedious tasks, allowing them to concentrate on higher value-added activities, in respect such as interpreting data, identifying optimisation opportunities and formulating strategies. Nonetheless, the use of AI tools is having an impact on the role of the management controller as a business partner, by strengthening his/her role in supporting decision-making. Similarly, they save a considerable amount of time. The management controller must now adapt to these changes in order to support the implementation of these new methods, developing new skills in mathematical modelling and economic analysis, as well as in data analysis, etc.

In the light of the facts set out above, it is important to note that although AI offers many opportunities, it alike poses challenges such as data confidentiality, ethics in the use of algorithms and the impact on employment, which need to be considered in the context of management. Finally, it should be stressed that AI is seen as an assistant and not as a system that can replace the human being.

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