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Typology of Information Systems in big companies

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Typology of Information Systems in big companies

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Foreword: acknowledgements

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1. Abstract

The growing number of data and information that companies need to manage, the growing complexity of operational processes and the technological evolution are three trends that grow and require the development of Information Systems (IS) for companies. An Information System is the combination of different components such as hardware, software and telecommunications networks that people build. This is used to collect, create, and distribute useful data in an organisation. [Wikipedia contributors, 2021]. Despite being present since several years, Information Systems are more and more used and appear to be a "must-have" for companies. It exists a lot of IS that are dedicated to a wide variety of fields.

Based on the literature and IS providers, the aim of this work is to build a cartography of existing Information Systems. To do so, this work starts with a historical introduction to understand the trend around IS and technological evolutions. Then theoretical aspects are mentioned: Information, System, and finally the combination of both, Information System. Afterwards, some elements are discussed to understand how it works to design an IS, to analyse it and so on with the part "Audit of Information System" and "System Development Lifecycle". Then, the different types of Information Systems are addressed, and a cartography tries to be done thanks to Gartner's magic quadrants about several Information Systems. Last, some links are made between these IS in order to understand how it works inside a company, what can be the relations between these systems and their hierarchy. This last section allows to understand why there are so many systems available.

2. Introduction

Historically, companies have always faced big changes through the years. There were hierarchical changes, geographical changes, some industrial revolutions, etc. Some big changes in the production happened during industrial revolution. During this period, production processes were completely modified in Europe and in the United States [Wikipedia contributors, 2021]. Some other changes appeared afterwards with, for example, a switch from a pyramidal management to a more transversal one. With the transversal hierarchy, you do not have a clear boss and you are not simply an employee with a responsible. The idea is to promote collaboration rather than hierarchy using a flatter system [*Management pyramidal versus Management transversal: évolution de l'organisation des entreprises*, 2015]. With the industrialisation and the new means of travelling, another change appears in companies: globalization. This phenomenon explains the bigger and bigger interdependence of the economies, cultures, etc between countries from all over the world. For example, there are partnerships between the USA and European countries that can be justified by the term globalization [*What is globalization*, 2018]. This means that companies are also growing and considering different countries to implement their activities.

Another very important trend that needed to be considered in general was the numerical or digital transformation of the world. Concretely, digital transformation is: "*The adoption of digital technology to transform services or businesses, through replacing non-digital or manual processes with digital processes or replacing older digital technologies with newer digital technologies*" [Wikipedia contributors, 2021]. The consequence of such digital migration is that companies are facing and dealing with more and more data. According to some studies, we generated 44 zettabytes (1 zettabyte = 1000^7 bytes) of data before 2020 and will generate 175 zettabytes of data globally by 2025. So, the datasphere will be nearly four times bigger in five years [*How much data is created every day?*, 2021].

Considering the growing number of data, firms have a clear need to structure all the data. Indeed, by using data, companies can generate information which is mandatory for their activities:

forecasting, planning, reporting, etc. That is why a new tool appeared to manage processes and data in companies. This tool is called Information Systems. They were created in order to collect, structure and share information inside companies, and now, they appear as some of the most powerful tools that we can find. Indeed, companies cannot exist without performant IS.

Since the years 1960, they have evolved. From simple administrative automation, IS are now useful tool to manage knowledge and globalization. They have also covered other fields such as Observe the processes and evolutions, performance management, etc. There are five steps in the development of Information Systems according to Paris university (Sorbonne), each step going further and bringing more added value to the process. [Nurcan & Rolland, s.d.]:

1) Administrative automation
2) The management observatory
3) Operational performance support
4) Infrastructure for cooperation and openness
5) Knowledge management and globalisation

On a technological point of view, the digital transformation and the linked development and growth of information systems were possible because of some technical evolutions. Indeed, materials and technologies have faced improvements that have allowed further development of these systems: Internet, hardware and software capacities, cloud technologies, … [*Histoire des système d'information : de l'agilité informatique à celle des organisations,* 2016], [Analyse stratégique, s.d.].

Other trends justified the increased number of data created and the need of IS: the reduced lifecycle of products. In addition to that, we are consuming more and more in a shorter interval. This means that we consume more and more because of the product lifecycle and because of the trend that we must consume more. With that, more data is created, there is more demand to manage for companies, … So, Information Systems appear as a solution to manage these growing trends and to solve some issues [Analyse stratégique, s.d.].

3. Information

a. Definition

The information can be defined in several ways. Indeed, the word "information" is often used in a large panel of fields. Often, there is a misunderstanding with "data". When the word "data" is mentioned, people talk about the facts, about what is required to have information. Here, the definition we are looking for is the following: "*Information is increasing the knowledge already known: it contributes to the set of facts and concepts one knows and depends on the context, on the question one is asking (answer to a request, result of a decision, document of a transaction, report)*" [*Introduction et typologie des systems d'information.* s.d.]. In other words, information can be defined by the resolution of uncertainty. When it is linked with data, information means the values attributed to parameters. It can be considered as the data in context and also with meaning attached. To summarise, information can be seen as the previous step before knowledge, where knowledge is the capacity of understanding an abstract or concrete concept. [Wikipedia contributors, 2021]

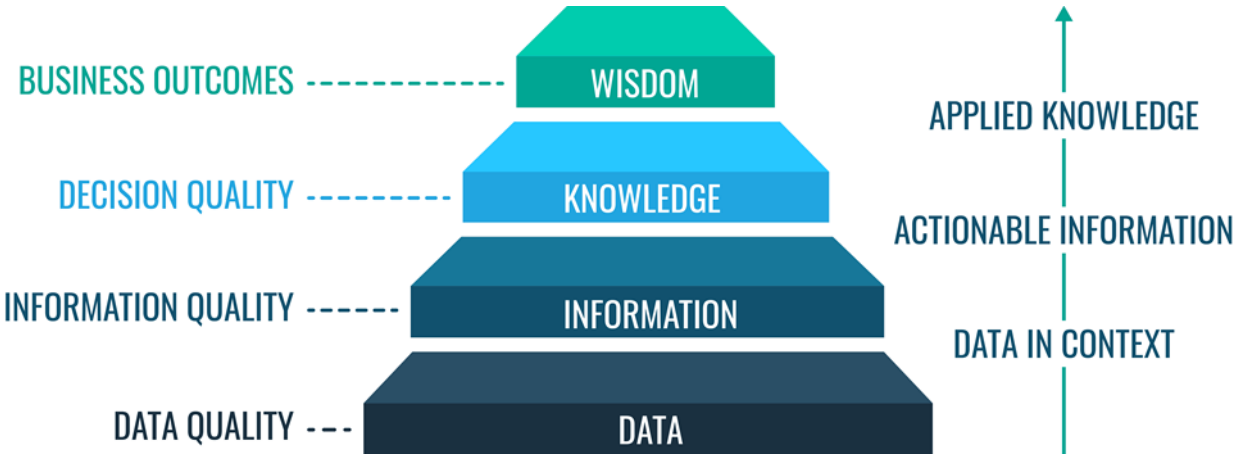


FIGURE 1: UNDERSTAND WHAT IS INFORMATION [DATA QUALITY-WHAT, WHY, HOW, 10 BEST PRACTICES & MORE., S.D.]

In companies, information plays several roles. The first role that comes to mind is the fact that information keeps some history of activities. Once the data is recorded and sorted, it becomes information that keeps track of previous activities. When everything is written down in a software, it is possible to find out which activities were made, by who, etc. Another role is the support for action. As an example, if a company knows exactly what it has in stock for a given product, the company can adapt its selling techniques to the level of stock. Last, information plays a role in the decision-making process of the company. The company uses the information to make some conclusion and to give weight and priority to its decisions. In other words, information can shape the companies' behaviours by providing insights in the decision-making processes. [*Introduction et typologie des systems d'information.* s.d.].

b. Characteristics

Several aspects of the information can be evaluated to check its quality. Here are different characteristics that information should have [*Introduction et typologie des systems d'information.* s.d.]:

- **Availability**: Information is always available and is still correct when required.
- **Completeness**: Information is complete when a user exploits it. That allows him to have full ability to understand the situation where the information is used.

- **Briefness**: There is no useless elements in the required information. Information provided is concrete and no part can be deleted without an impact on its sense.
- **Importance**: In addition to the briefness, the information only contains elements that are very important/relevant regarding the situation.
- **Accuracy**: There is no mistakes, it only reflects the reality it is dealing with. Without accuracy, Information would be useless.
- **Precision**: Quantitative information with a degree of accuracy as required.
- **Form**: Contain as many details as it is asked by the user taking the situation into consideration. Information can be displayed using several formats: graphs, tables, etc.

c. Types

Information can be from two types in a company, we have [*Introduction et typologie des systems d'information.* s.d.]:

- **Internal information** which is information inside the company. For example, there is information on processes, products, internal resources, inventory, etc. This information belongs to the company. It is managed by the Information System of the organisation.
- **External information** which is information from outside the company. For example, there is information on customers with the marketing strategies, information on competitors with the product quality or the market, … That can also be managed for some points by the IS of the organisation, but it can also be collected with external sources like some websites, market surveys …

4. Systems

a. Definition

A system is « a set of things working together as parts of a mechanism or an interconnecting network; a complex whole.", "a set of principles or procedures according to which something is done; an organized scheme or method" [Oxford Dictionary, 2021], "a group of interacting or interrelated entities that form a unified whole. A system is delineated by its spatial and temporal boundaries, surrounded and influenced by its environment, described by its structure and purpose and expressed in its functioning". [Wikipedia contributors, 2021]

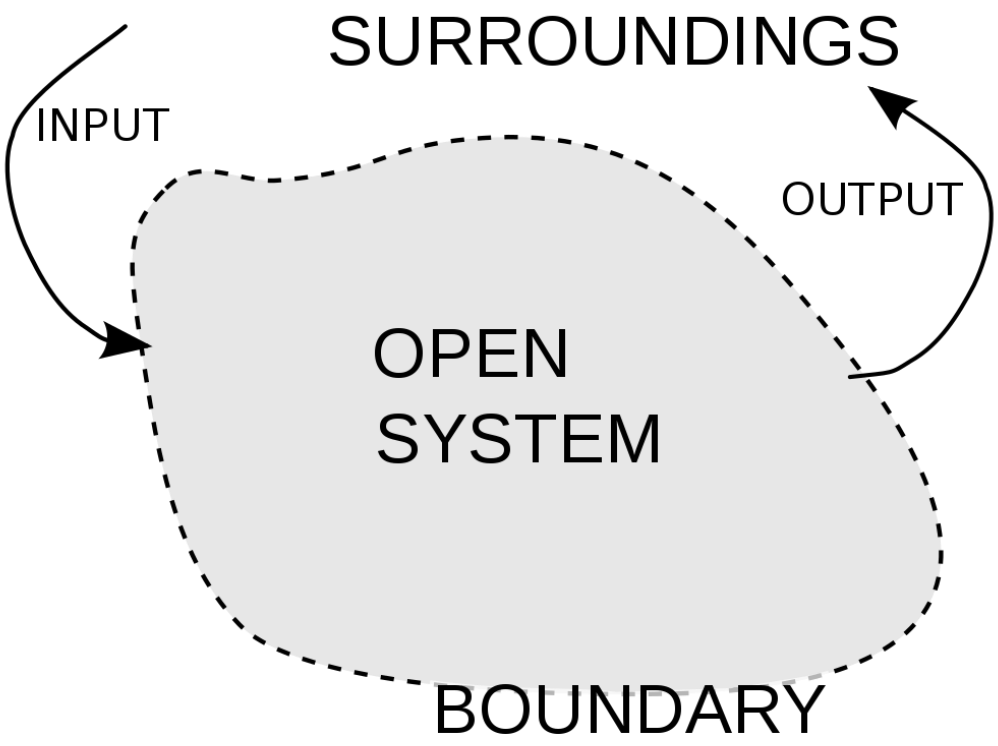


FIGURE 2: HOW DOES A SYSTEM WORK? [WIKIPEDIA CONTRIBUTORS, 2021]

Moreover, there is a need to introduce the system theory such as to clearly understand how it works. A system is delimited by the time and the space. It also has some boundaries which means that some entities are put inside the system while others are outside. Among the elements that influence the system, there are: the environment, the structure, the nature and the functioning. Considering all these elements, it is important to notice that if one part of the system changes, the whole system can change. That is due to the interlinked relations in the system. [Wikipedia contributors, 2021]

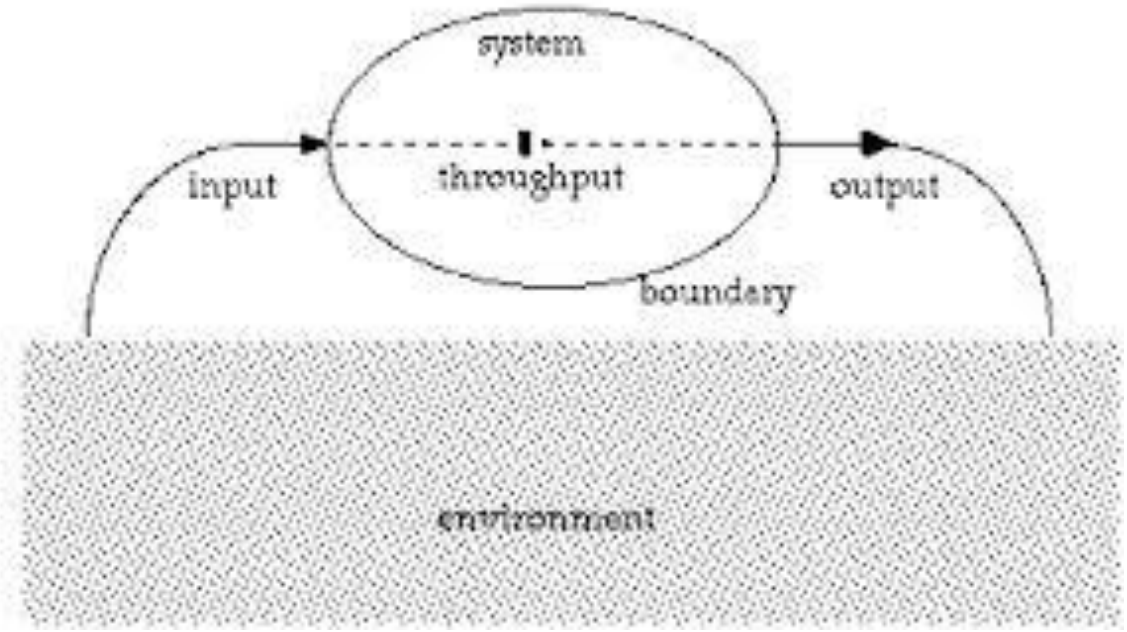


FIGURE 3: BASIC CONCEPTS OF THE SYSTEMS APPROACH [HEYLIGHEN, 1998]

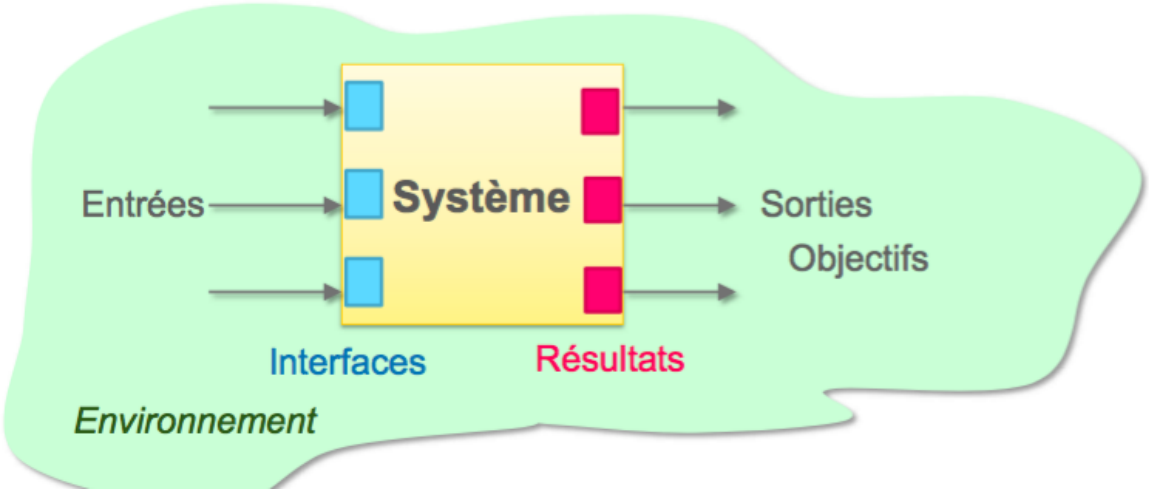


FIGURE 4: HOW DOES A SYSTEM WORK [INTRODUCTION ET TYPOLOGIE DES SYSTEMS D'INFORMATION. S.D.].

For instance, a change in the environment of a system can have an impact on the productivity, then this can have an impact on the inventory and stocks, which can have an impact on something else, etc. So, one change can have several effects on the system.

5. Information system

a. Definition

Information system can be defined as followed: it is the combination of different components such as hardware, software and telecommunication networks that people build. This is used to collect, create, and distribute useful data in an organisation. [Wikipedia contributors, 2021]

The underlying objective of such IS is to provide a support in the decision-making process and more generally to provide value to the company. For example, an organisation can take decision regarding his efficiency by making some analysis of its data. That is the purpose of IS.

More technically, the use of information system can be illustrated in three steps that are applicable to all types of Information Systems: [Bourgeois & Bourgeois, 2014]:

1) Collect, store, organise and distribute data for the organisation.
2) Transform this data into information. That means that some context and a meaning is added to the data to make it understandable.
3) After that, information is transformed into organisational knowledge.

b. Components

In an information system, there are two different components that are then subdivided in more detailed categories. We often think about the technological part of the IS only. That is indeed a major part of the subject but there is something else that makes IS different. Indeed, there is a part dedicated to communication in such a system. To make an information system works correctly, all the different components have to work together. We thus have the technological part and the communication part.

i. Technology

In this part, we can consider different elements [Bourgeois & Bourgeois, 2014], [Wikipedia contributors, 2021]:

- Hardware: It is the “solid” part. We can touch it and so it is the physical component of the technology. It is thus the tangible part of IS. As examples, there is a computer, a hard disk, keyboard, … It is not always at proper part of the IS (indeed, there are cloud technologies), but it is required to make it works.
- Software: In opposition to hardware, software is intangible. This is just instructions grouped together that tell the hardware what it must do. There are two types of software: first, the operating-system software which allows the hardware to be used. Then, there is the application software which makes the hardware useful. For example, we have Microsoft Windows as operating-system software and Microsoft Word as application software. Windows allows a computer (=the hardware) to work while Word offers the possibility to type some texts on the computer.
- Data: As the software, data is an intangible element of IS. Moreover, taking into consideration individually, data does not appear to be a useful element. But when you consider data aggregated, sorted, cleaned, … which means data in a database, it appears as a very useful element.

- Network: it allows the system to be connected. That is useful to use, collect, clean data, this is also useful to make the different agents of the systems communicate, … The network will make the link between the technological aspect and the communication aspect of IS.

ii. Communication

Before, communication was not a core concept of IS. Nowadays, the communication aspect of IS must be considered. This component is now essential when talking about this topic. We cannot consider a system without interactions because of the hyper connected world we are living in. We have to consider two elements in this section [Bourgeois & Bourgeois, 2014]:

- People: It is an essential element in an information system. Indeed, people play a role in different steps. There is a need to make the hardware, there is also a programmer required to make the software, there is an analyst needed to analyse the output of the system, … So, it clearly appears that people play a massive role in IS despite the automated property of some Information Systems.
- Process: Information systems are now part of the processes in companies. A process is the set of steps which have to be performed to reach a define goals. These steps can be workflows, actions, activities, etc. Once they are connected, they will form a process.

c. Dimension problems faced by IS

The information systems cover a very large range of domains. Because of this wide range, the information systems face several problems which must be resolved. These problems can be classified under three dimensions. [Hasselbring, 2000]: distribution, heterogeneity and autonomy.

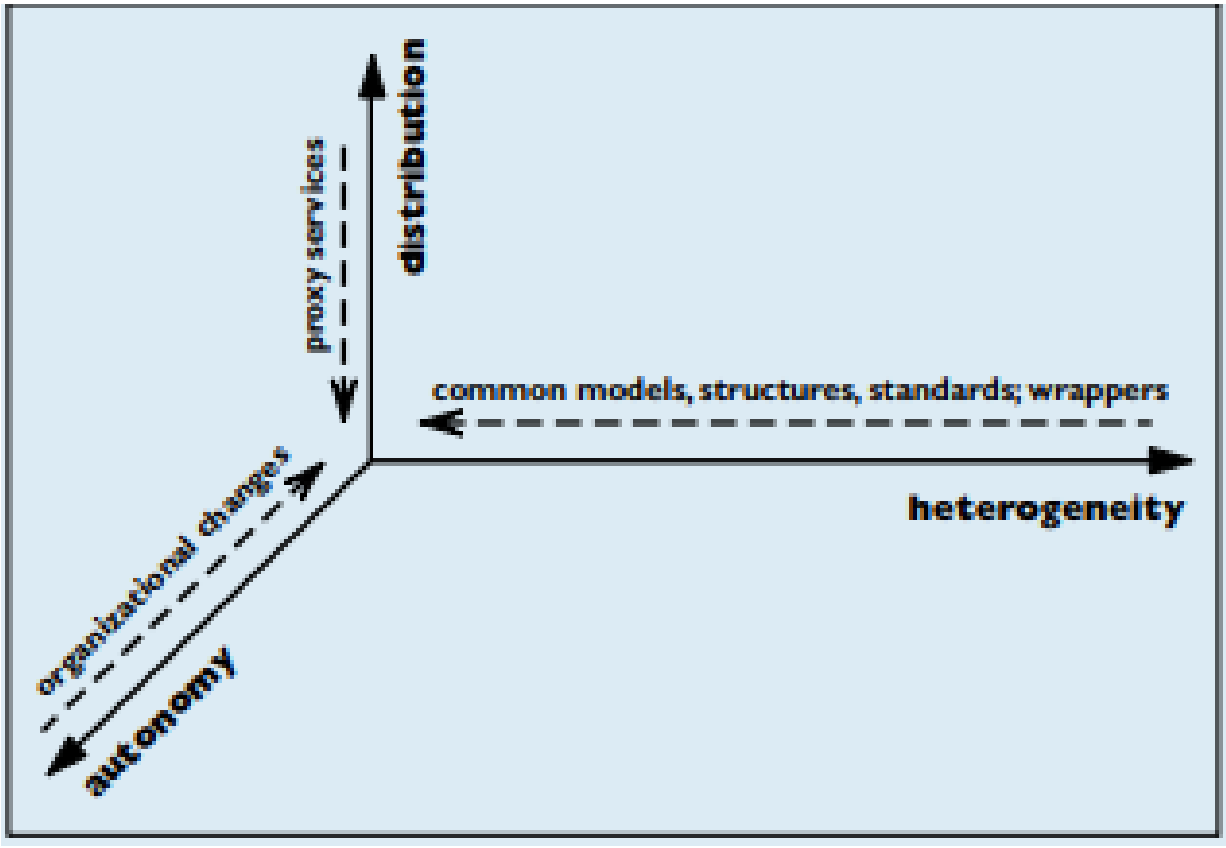


FIGURE 5: DIMENSION PROBLEMS FACED BY IS [HASSELBRING, 2000]

i. Distribution:

There is a need to distribute the information through the systems. The origin of the dimension "Distribution" is due to the fact that there are multiple systems built before the overall system. Indeed, every department of a company has its own system that manages the information dedicated to this department. Nowadays, a lot of information can be useful for several departments. It explains the requirement of an overall system. Here is why distribution is useful.

One typical solution used by companies is the proxy service. It is a technique that makes it possible to hide the distribution. [Hasselbring, 2000]

ii. Heterogeneity:

The heterogeneity comes from the different databases and operating systems utilized. Indeed, every system has its own way to be developed. That leads to differences in many levels. Concerning the technical aspect, heterogeneity can come from: the programming language that can vary from one system to another, the hardware platforms that are not always compatible, the management of the data, … For the conceptual aspect, the differences can be due to different programming or data models, data types, and also to different understanding of real-world concepts.

Solving this problem is the biggest challenge of Information Systems. The easiest solution is to have a standardization of the process. For example, the goal is to use common programming models, data models and structure the information in the same way for every system. [Hasselbring, 2000]

iii. Autonomy:

Another problem faced by IS is the autonomous part of the system. The problem is generated by the conflict between requirements of integration and autonomy. The autonomy concerns two aspects: there is first the autonomy of components design as the programming models used, the naming conventions, … but there are also the autonomous communication and execution of the system which are related to the component ability to interact with the outside world.

Reducing this autonomy by using technology seems difficult. The only way to manage autonomy in IS is to make organizational changes. Companies need to be built thinking about the Information Systems to offer them autonomy. [Hasselbring, 2000]

d. Advantages and opportunities

Using Information Systems in a company offers several advantages that cannot be neglected. These advantages motivate the implementation of such systems in various fields. We have [Silvan, s.d.]:

- Custom information: by using an IS, the information provided to a user (manager, employee, …) is customized in order to be as useful as possible. For example, in case of a meeting between high-level manager, the data displayed can be classified by month. The objective of the meeting would be to identify which months were the best months in terms of sales. On the contrary, a meeting between marketers would regroup the sales regarding another criteria: a customer has been contacted by a campaign vs a customer which has not been contacted. The data comes from the same data set, but the information is used differently to meet the needs of each targeted stakeholder.
- Custom formats: here also, the information can be provided according to different formats. For example, let us consider data displayed through a graph. In a sales meeting, data can be

displayed into a pie-chart showing the sales of the company compared to the sales of other companies to analyse the market share. In another meeting, the same data can be used and displayed in a column chart to compare the sales over time.

- Real-time information: because the data registration and handling are likely to be automated with IS, the information can be provided in real-time. An example of this advantage is when a problem occurs in a system, thanks to the IS, it is possible to identify the cause of the problem: mechanical failure, lack of material, etc. Moreover, this real-time information allows companies to react quicker than before when facing an issue.

- Adaptability: because of the constant evolution of the world, IS are very flexible and can be adapted for some special cases. That is very useful. For example, if a company launches a new department or subsidiary, the system can be extended to cover its needs.

By adopting information systems, companies have expectations concerning their effects. This can also be seen as some advantages provided by the systems [*Introduction et typologie des systems d'information.* s.d.]:

- Reinforcement of the competitive positioning of the company. For example, it will allow a firm to react quickly to some modifications (for instance modification of the laws, modification of the competitors' strategies).

- Decrease of the production costs. Thanks to the system, companies will be able to identify possible modification in the process that can decrease the costs. For example, useless steps in processes are directly highlighted and modified.

- Increased productivity. The system will be able to show points where failures can occur, bottlenecks, etc. Thanks to that, companies can modify the process and increase production.

- Product and service quality increase. This point can be linked with the previous one. Indeed, when a process is redesigned (here it is the case with IS), both productivity and quality will increase [Meunier, 2020].

- Increase decision capacity and rapidity. With all the information available quickly and with the right format and scope, companies can take decisions in a better and faster way.

- Communication possibilities are increased. Indeed, IS connects different parts of a firm, the departments, … Thanks to these connections, it is easier for members to communicate. Moreover, the process is simplified to make them interact.

- Working conditions are better. Because of all the points mentioned previously, it appears that working conditions are much better for employees in a firm that uses Information System.

  Moreover, it allows companies to see the management of information in a different way. [*Introduction et typologie des systems d'information.* s.d.]

- Business objects are no longer material goods. They are now totally dematerialized because of the IS. A simple example concerns a plane ticket. Nowadays, you do not need any more to have it in paper in your hand; your E-ticket is displayed on your mobile phone and it will work as well.

- Another aspect is the dematerialization of products. Now, we have more and more streaming in comparison of having real films. This is only an example amongst many others.

6. Audit of Information Systems

The information system that a company wants to build is based upon several criteria. The environment, the economic context, the type of company, … play a role in the implementation of IS. Nevertheless, the main objective of a company is ensuring profit maximisation. This is the key driver that motivates companies to implement Information Systems.

A company must consider different aspects to develop its strategy. At first, there is the Business Process: what activities are planned to be done, what are the steps that must be fulfilled, … Secondly, there is the Functional point of view: who is responsible of a given task, who manages the team in charge of a project, etc. After that, it seems clear that there is a need of Applications to manage projects. This is the third point. Last, there is a Technical part in the project: the computer department which makes relations between elements. [*Explication des vues du Système d'Information: exemple*, s.d.]

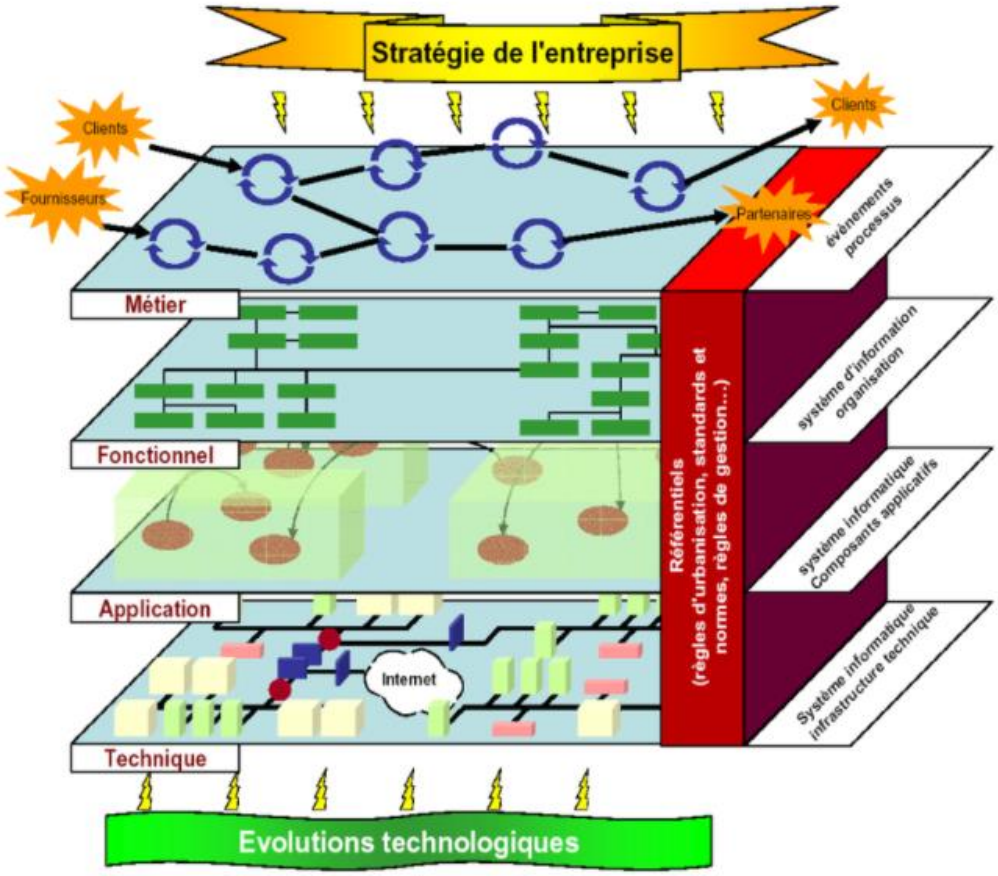


FIGURE 6: COMPANY'S STRATEGY [EXPLICATION DES VUES DU SYSTÈME D'INFORMATION: EXEMPLE, S.D.]

In order to develop the best IS that will support the needs of the companies, each company has to perform different analysis:

a. Strategic analysis

As a reminder, the strategy is the definition of the company's objectives (either short or long-term ones), the means put in place such as to fulfil them and their monitoring. With the evolution of the current society, the strategies are varied. In the middle of these strategies, we find Information Systems. Here are the different strategies we can have in order to face the evolution:

- Innovation: Develop and launch a new product (good or service), a new technology, … That means going from scratch and develop something that is not available on the market. Innovation can be risky but when it is well-managed, it generates many benefits for a company.
- Rupture/Break-up: Change the brand image, the strategy, … It means that the organisation remains the same, but changes are made to return to profit or improve profit. The changes can be from varied domains.
- Conquest: Keep the same market but in addition, develop something new to reach new markets. The companies extend their targets using such a strategy and consequently their sales level.
- Process optimization: improving communication, forecasting changes, eliminate redundancies, increase capacity to avoid bottleneck problems, … [*Business Process optimization-Definition, steps and examples,* s.d.] This should lead to sales increase and cost reduction.
- Increase margins and efficiency. This can be performed through the process optimization aspect.
- Differentiation: Currently, there is a lot of competition between companies, and they need to find a way to be different of their competitors. By adopting a differentiation strategy, companies will emphasise on their Unique Selling Proposition.

Those strategies have all positive and negative aspects that have to be considered before implementing them. Moreover, the choice of the company also depends on the nature of the decision: it can be a wish of the company, so the decision is deliberate, or it can be a reaction to some market trends, threats, … In this case, the decision is undergone. [Analyse Stratégique, s.d.]

b. Processes analysis

After having defined a strategy, the company needs to focus on its processes. Indeed, processes have to be adapted to the strategy developed. Thus, some processes need to be re-thought and reengineered. [L'analyse de processus, s.d.]

To identify clearly what has to be modified, companies can model processes using Business Process Modeling (BPM).

c. Functional analysis

Now that the strategy and the process are both defined, there is a need to fulfil the functional aspect. To do so, a company may need to hire someone with a specific profile, … Therefore, the company will have to complete its organigram. However, it is important to mention that the company's hierarchy is not as pyramidal as before because of Information Systems. Indeed, it flattens the organigram. [Analyse fonctionnelle, s.d.]

d. Applicative analysis

In this analysis, the aim is to analyse the different applications available in the company to see if these applications can fulfil what have been identified through the previous analysis. Moreover, it helps to delete the software that are not very useful or that are duplicated in the company. Thus, through this analysis, the goal of the company is to answer to the following question: "Do we have the

required software in order to make what we decided as strategy, business process, etc?". [Analyse applicative, s.d.]

e. Data analysis

Every company has data available and needs to optimize the outcome and take benefits of such data in the current society. The management and authorized employees thus need to have access to the data and information at any given time. That is very useful to create value inside the company. Because these data are so valuable, the company has to manage carefully the data security. Indeed, a company cannot face a situation in which it loses all its data or have all its data hacked.

After having managed and protected its data, a company can start the data modelling to create added value. [Analyse de données, s.d.]

f. Infrastructure analysis

Another point that has to be mentioned is the infrastructure around the company.

There is at first a transactional system. This system allows the company to note down all the performed transactions.

Another aspect of the infrastructure is the client-server architecture. The client contacts a server that gives him the required information. It allows to centralize the information, to have a better security and is kind to evolution. But it has a certain cost because of the monitoring, the technology required, …

Nowadays, we often find architecture called 3-tiers (and even more and more n-tiers but it remains the same logical approach). It this architecture, the client makes a request through the network, the query made by the client is treated by an application server and then sent to another data server where the information is stocked. After that, the client receives the researched information. [Analyse de l'infrastructure, s.d.]

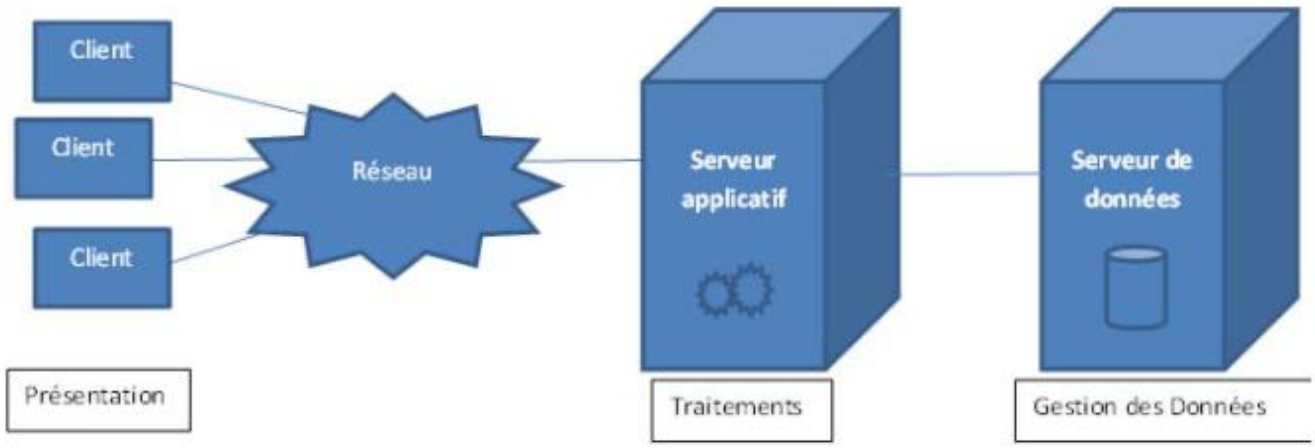


FIGURE 7: INFRASTRUCTURE SCHEMA [ANALYSE DE L'INFRASTRUCTURE, S.D.]

g. Technological evolution analysis

Despite having implemented the best possible Information System, a company cannot neglect the technological evolution. If a company does not follow the new technological evolution and does

not implement and update such new technologies, this company can quickly be out-of-date, and its system can quickly be obsolete and thus inefficient. [Analyses des évolutions technologiques, s.d.]

7. System Development Life Cycle (SDLC)

A company can use the System Development Life Cycle to develop its information system after having made some analysis.

a. Definition

"*System Development Life Cycle is a process that produces software with the highest quality and lowest cost in the shortest time possible*" [Alvater, 2020]. So, this is a tool that provides structure to help an organisation in the design of its systems. It can also be defined as: "*A conceptual model used in project management that describes the stages involved in an information system development project, from an initial feasibility study through maintenance of the completed application*" [Gillis, s.d.]. The output is a high-quality software well-tested and ready for production use.

By using a SDLC, a company is able to decrease the software development costs while increasing the quality and decreasing the time to produce products. In the process, the aim is to avoid the traditional mistakes that are faced in such a development. [Alvater, 2020]

b. Steps to follow

The SDLC follows a clear process to develop a new system. The different phases are shown in the following graph [Alvater, 2020]:

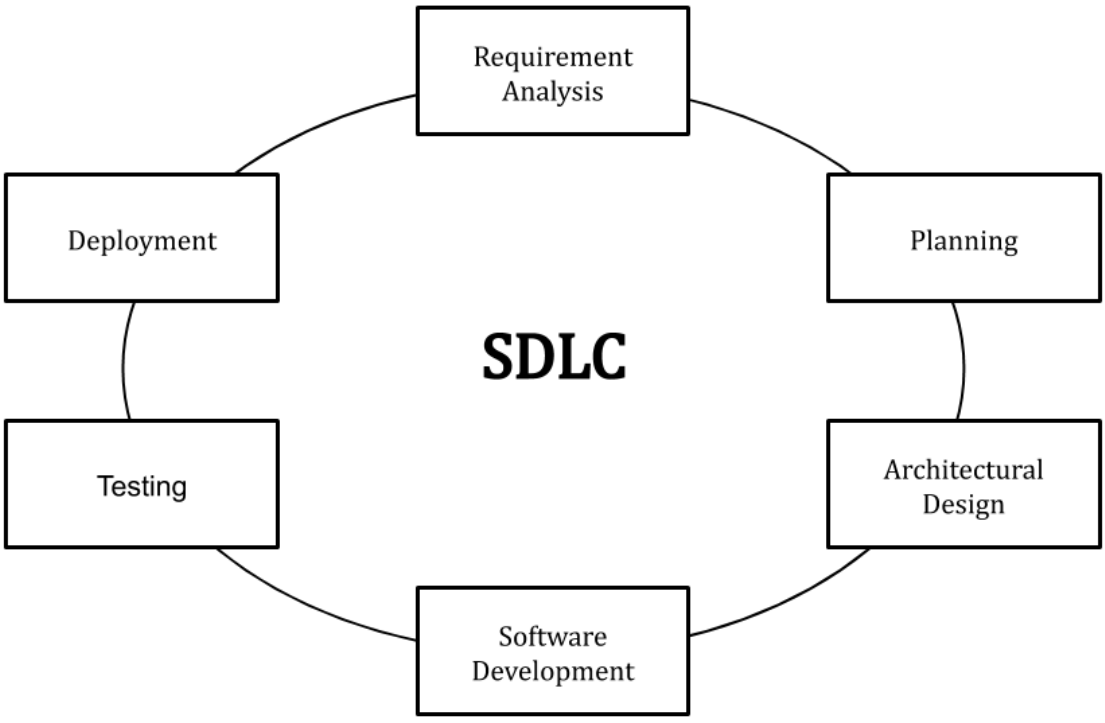


FIGURE 8: SYSTEM DEVELOPMENT LIFECYCLE SCHEMA [ALVATER, 2020]

i. Requirement analysis

First of all, if a company wants to develop a new system, it has to focus on the potential problems this system is able to solve. So, the main question they have to ask themselves is:" What are the current problems that have to be solved?". To do so, an analysis of the stakeholders and of the potential problems is very interesting. By doing so, the company will highlight different gaps and requirements. The main objective has to be the improvement. [Alvater, 2020]

ii. Planning

Now that the requirements are identified, the next step is to find what the company is expecting from the system. The company will thus determine the feasibility of the project. To do so, the budget will be defined: cost and resources that the company is willing to invest in the development but also the potential risks and solutions to avoid them. This step consists thus in a feasibility study. [Alvater, 2020]

iii. Architectural design

Let us now consider one of the most important steps of the process. The company will put emphasis on the "How" of the project. They have to make a Design Specification. This plan is then reviewed by stakeholders until they all agree. With that iterative approach, the company is certain that everyone gives his recommendation and that all requirements are identified. [Alvater, 2020]

iv. Software development

Now that we have the requirements, the budget and the design specification, the development can start. This step can be very long and requires rigor. Indeed, some guidelines like naming convention for variables in the code are required to have a good software development. It will be very useful for the testing phase and for some maintenance phases that can occur after the deployment. Without a clear and organized software development phase, companies can lose a lot of time. [Alvater, 2020]

v. Testing

After the development, the produced software will face some tests. The objective is to confirm that the software fulfils the requirements identified in the first step and meets all the specifications defined in the design specifications. [Alvater, 2020]

vi. Deployment

If the testing phase appears to be a success, the company is able to launch his new software. Users will thus be able to start using the product. Often, the deployment is made softly. That means that companies launch the system at first to some stakeholders to verify that it fulfils requirements and to have some field tests. [Alvater, 2020]

vii. Maintenance

When a product is deployed, the company continues to work on it to make some corrections, improvements, updates, or extensions. Indeed, a plan is nearly never perfectly fulfilled when it meets reality [Alvater, 2020]. The system may require updates or changes. That can concern the hardware or the software part of the system. These parts can be upgraded, replaced, or changed. The overall objective of maintenance phase is to provide better quality to users. [Gillis, 2020]

c. Advantages

Using a SDLC model allows many advantages in the software development. Here are the main ones [Gillis, 2020]:

- It allows the company to have a clear overview of the project: an estimation of the resources engaged in terms of workers, costs, and time.
- The requirements are clearly identified: they define the goals and standards the project has to reach.
- Some models allow flexibility so that developers can go back if some steps are not fulfilling the requirements. That is for example the case of the Agile Model.

d. Disadvantages

On the contrary, there are also some disadvantages [Gillis, 2020]:

- Using models imply making assumptions. Some unexpected events not considered in the assumptions can jeopardize or at least bring additional challenges to the project.
- Classical models like the Waterfall Model are not flexible. In an IT world, it is not good to be rigid.
- Sometimes, the estimation made at the beginning of a project can be false. Indeed, some steps imply much more cost than expected.
- Testing phases can be long.

e. Models

Here is a non-exhaustive presentation of the most famous SDLC models.

i. Waterfall Model

This model is the oldest System Development model. In this model, when one phase is finished, the next one starts. So, when the first phase is over, it waterfalls into the second one and so on. This model is not used anymore in companies because of a big disadvantage: if one phase faces an issue, the entire process has to be retaken. The model does not allow flexibility and modifications despite reviewing the entire process [Alvater, 2020]. Concerning the positive part, this model appears to be very intuitive. Indeed, the process flows logically from one phase to another. [Hughey, 2009]

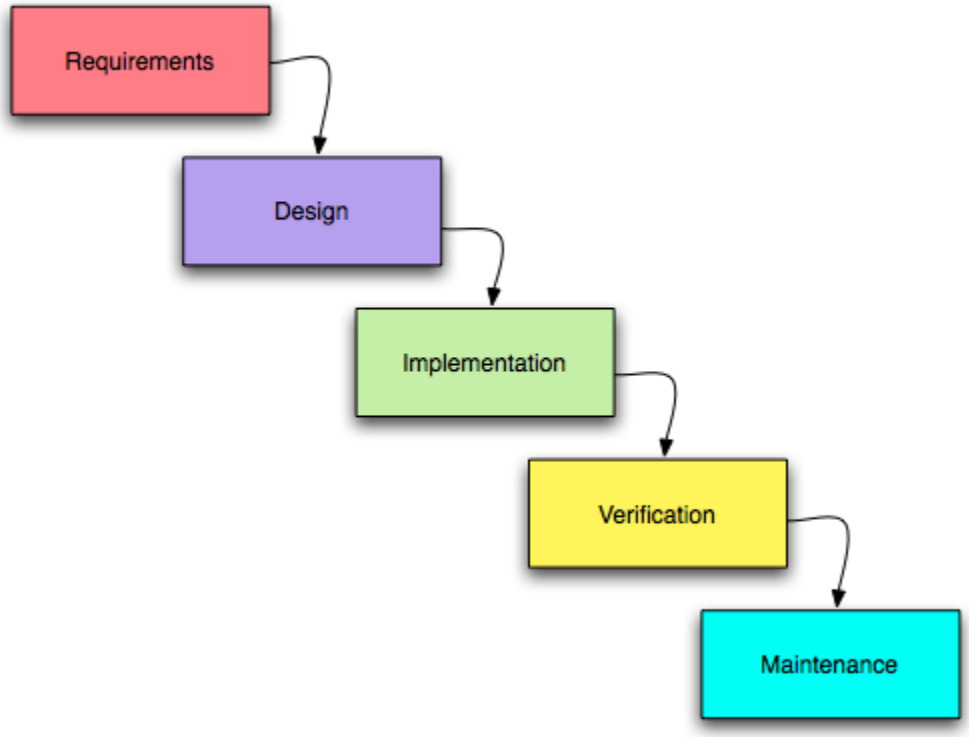


FIGURE 9: WATERFALL MODEL [HUGHEY, 2009]

ii. V-Shaped Model

The V-Shaped Model is an extension of the classical Waterfall Model adding some testing phases such as to avoid doing the whole process and facing problems that cannot be solved at the end of the process. Thus, this process adds a bit of flexibility. [Alvater, 2020]

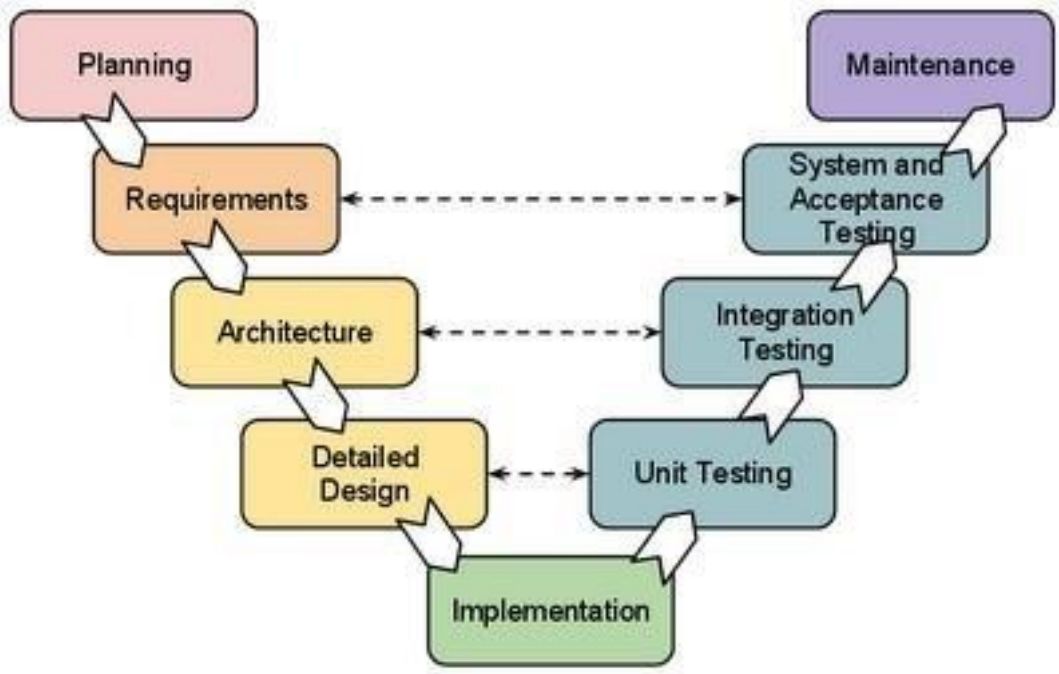


FIGURE 10: V-SHAPED MODEL [MIRAZ, 2020]

iii. Agile Model

This model is a quite recent approach in a project development. That consists in cycles and quick delivering of the product in a "beta" form. These cycles are called Sprints. Then, the delivered product will be updated until it reaches the requirements. Each new release of the product will be tested and incorporated into the old one. The problem of this method is the importance of the interactions with the customers that can lead the project in the wrong direction [Alvater, 2020]. In the opposite, one advantage is the adaptability of the model which is very useful in the constantly changing world we are living in. [Iphs, 2019]

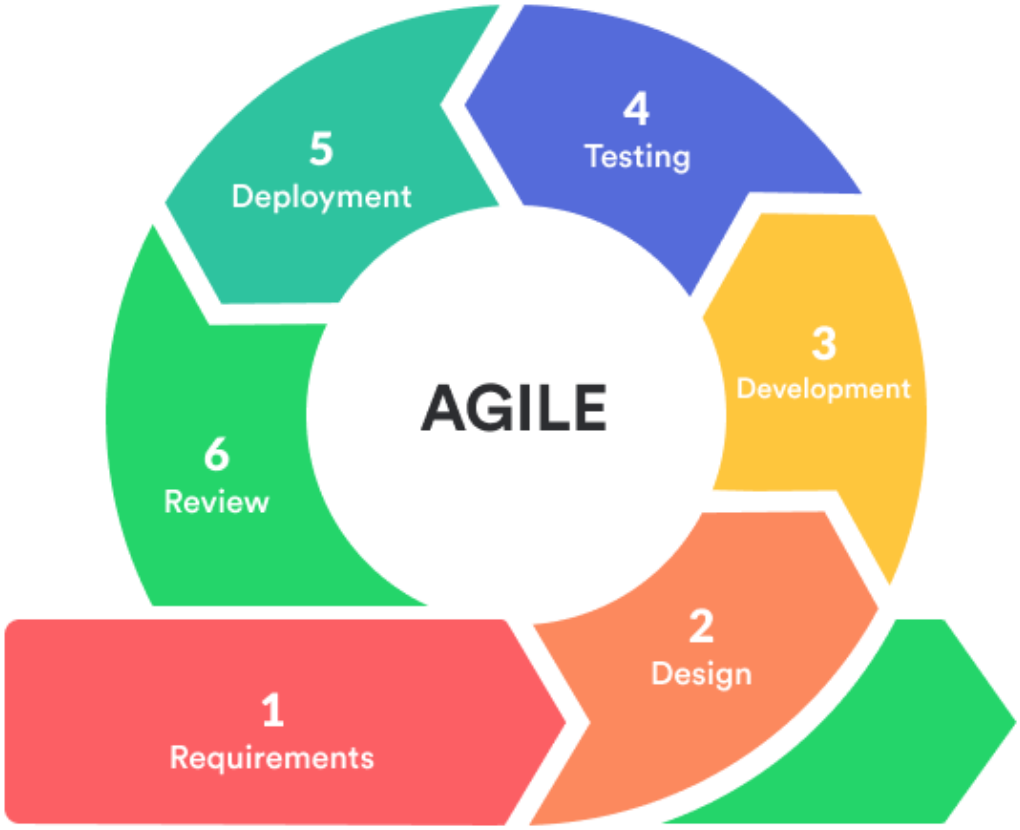


FIGURE 11: AGILE MODEL [IPHS, 2019]

iv. Iterative Model

The iterative model is based on repetition. The aim is to create a primary version quickly and cheaply. Then, the version is tested and improved throughout the iterative process. By using this model, the software will have many different versions. The biggest drawback of such a model is that it will consume a lot of resources (Time and Money) because the process will have to be reconsidered every time a new version is developed. But this approach will allow developers to take into consideration the feedbacks of users after every new step. That will create new requirements and increase the efficiency of the software. [Alvater, 2020]

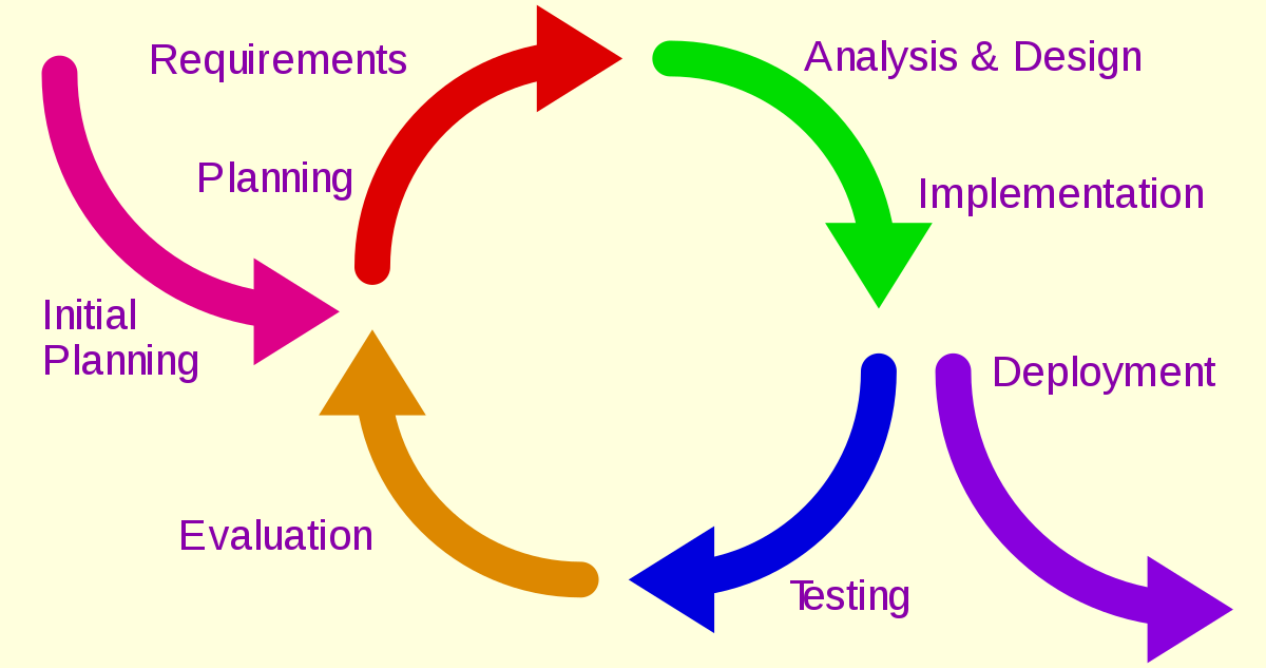


FIGURE 12: INCREMENTAL MODEL [WIKIPEDIA CONTRIBUTORS, 2021]

v. Big Bang Model

This model is the riskiest one. It consists in throwing all resources into the development and work as best as possible. In this approach, there is no focus on the requirements analysis and some analytical stages. Using such a model, companies can invest a lot of time, money and effort without reaching significant results. [Alvater, 2020]

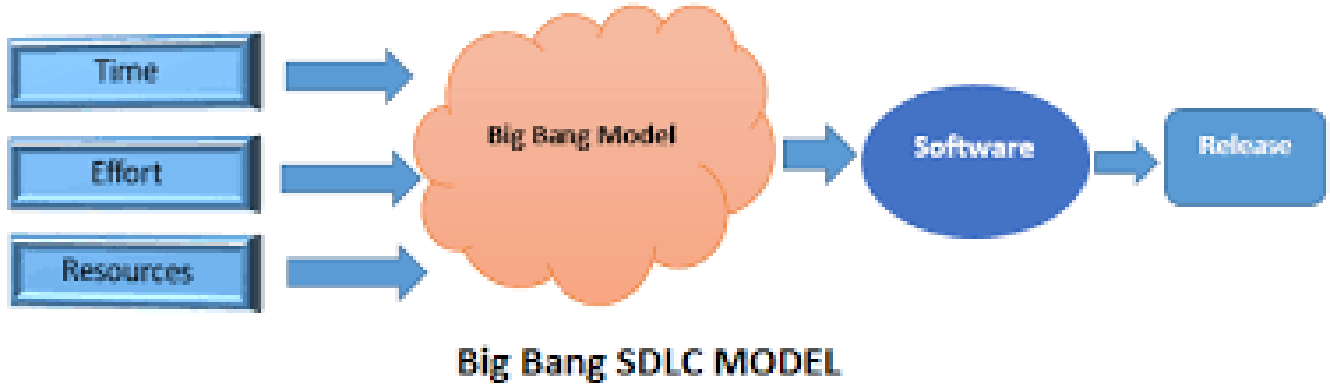


FIGURE 13: BIG BAN MODEL [BIG BAND SDLC MODEL, 2019]

8. Types of Information Systems

The information systems have encountered changes though the years. As the classical organisation hierarchy IS were classified in a pyramid to reflect the hierarchy that a company has. Nowadays, this model is no longer available because new systems have been developed and the organisation pyramid is no longer the good hierarchy. However, there are still some relationships between systems.

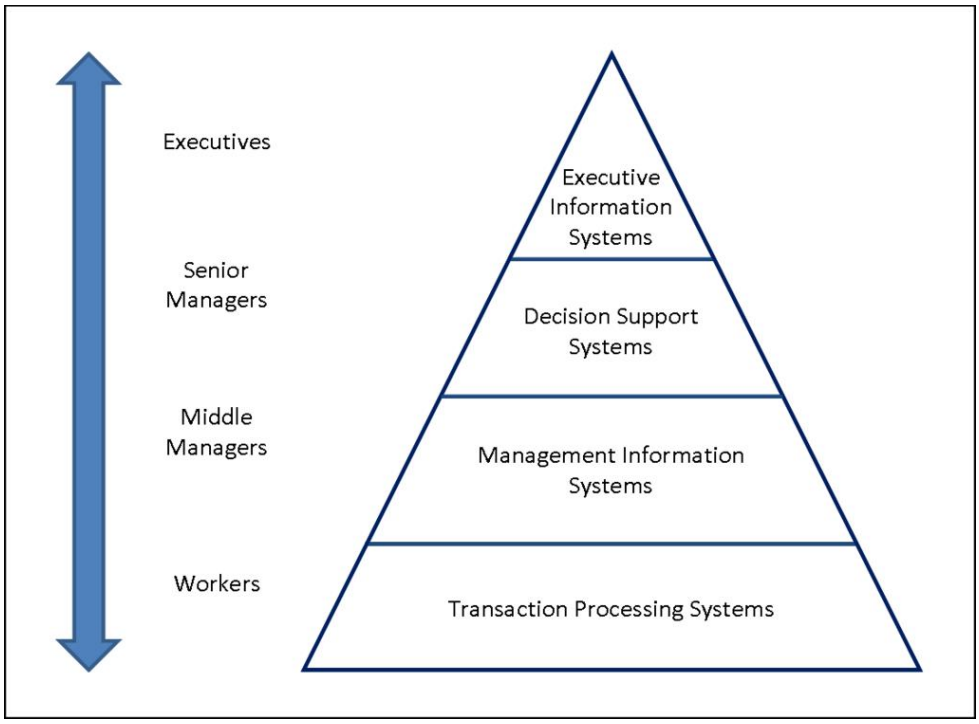


FIGURE 14: FOUR LEVEL PYRAMID MODEL [WIKIPEDIA CONTRIBUTORS, 2021]

On a general point of view, these systems can be divided in four categories: Sales & Marketing, Manufacturing & Production, Finance & Accounting and Human Resources [*Management information systems,* s.d.]. In this section, some systems will be discussed according to the fields they are belonging to. Some of them are a bit "duplicative" but it is sometimes interesting to mention all the possibilities in order not to miss an important information.

a. Information systems related to business and finances

- **Enterprise Resource Planning (ERP) :**

An ERP is a business management system that uses software like every information system. On a very general point of view, an ERP gives the opportunity to manage all the processes in a company and integrate them. More precisely, it is a suite of integrated business applications that will have different impacts on a company. This will provide a real-time view of the business processes in the company and will collect, store, manage and allow usage of data from different business activities.

This system will allow companies to integrate information from different departments (accounting, finance, HR, manufacturing, distribution, etc.) by covering end-to-end processes. It will also automate them. By doing that, the companies will be able to increase its revenues, take better decisions, have a better access to data, etc. This software is a very general one that can be used in a wide variety of activities. [Gartner Glossary, s.d.], [Wikipedia contributors, 2021]

- **Transaction Processing Systems (TPS) :**

This system is the basic business system. It is designed for the operational level of the company. It is: “A computerized system that performs and records the daily routine transactions necessary to the conduct of the business”. The aim of this system is to help companies when they make some commercial or logistic transactions. [Salem Al-Mamary & al., 2014]

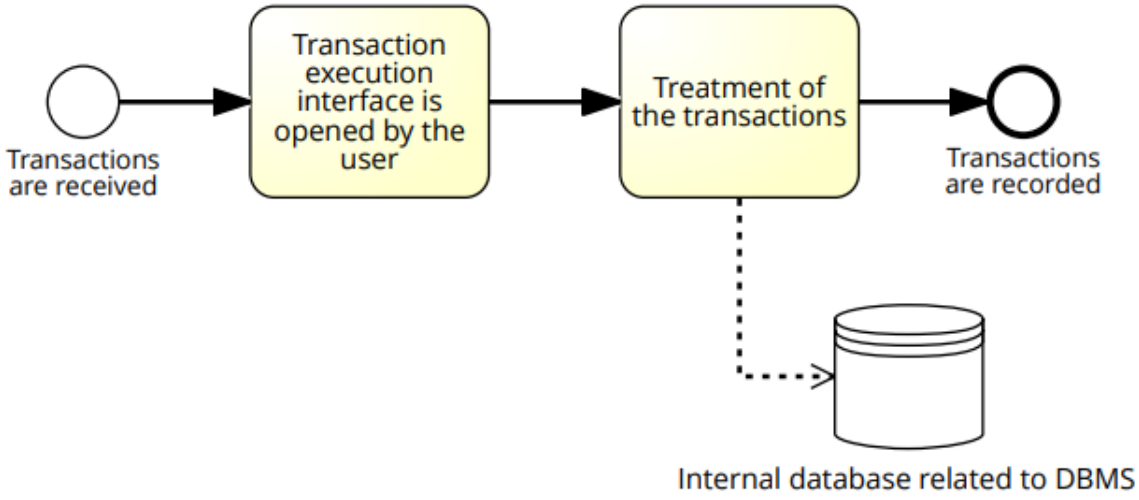


FIGURE 15: DESCRIPTION OF THE USER TRANSACTION PROCESS

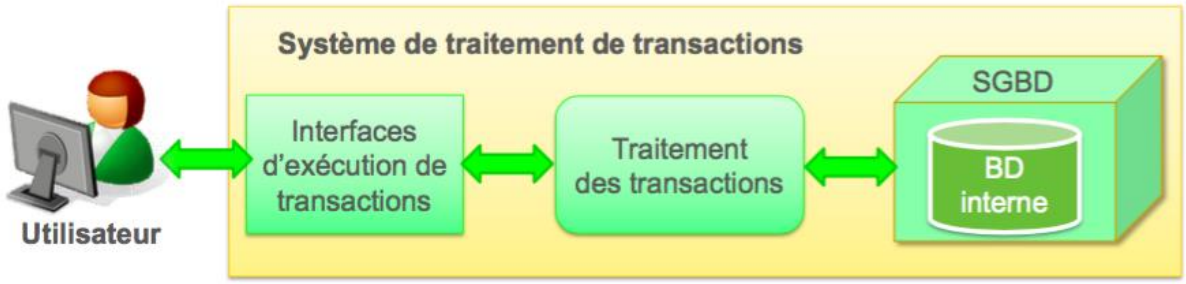


FIGURE 16: TRANSACTION PROCESSING SYSTEM [INTRODUCTION ET TYPOLOGIE DES SYSTEMS D'INFORMATION. S.D.].

Based on the picture, let us take the example of the sale of a product. The user will register the sale in the system which will make some operations to store the information (= a product has been sold) in the database related to sales. [*Introduction et typologie des systems d'information.* s.d.].

To sum up the way of working of such a system, it needs at first a user that has to make interactions with the system in real time. Thanks to that, the user can direct the system with the right instructions: collect, store, find or modify data. With a terminal, the transactions are entered in the system which directly stores them in the database. The terminal also produces an output to confirm that the transaction has been made. [Nordmeyer, 2019]

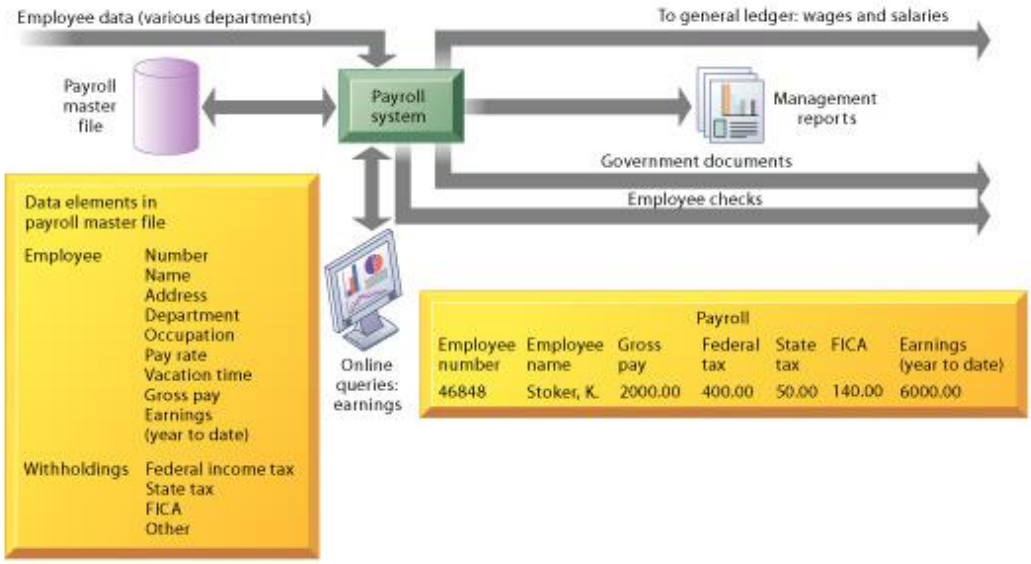


FIGURE 17: TRANSACTION PROCESSING SYSTEM EXAMPLE [*MANAGEMENT INFORMATION SYSTEMS,* S.D.]

- **Finance and Accounting Information Systems:**

Finance and Accounting Information Systems have two functions. First, the finance function which must manage the financial assets of the company such as the cash, stock and other investments. Then, the accounting function which has to maintain and manage the firm's financial records (=receipts, payroll, …). Using a software to do that allows the information to be quickly available and to automate some processes (accounting transactions for example). [Salem Al-Mamary & al., 2014]

- **Customer Relationship Management (CRM):**

This is the grouping of practices, strategies and technologies used by companies to manage and analyse customers interactions and data about the customers lifecycle. The aim of the system is to improve the relationships with the customers and avoid churn [Chain, s.d.]. Indeed, attract new customers is much more costly for a company than keeping the existing ones in the process. Another thing that CRM can do is the management of interactions with potential customers [*What is CRM,* s.d.].

- **Operational Database Management Systems (OPDMS)/On-line Transaction Processing Database (OLTP):**

This market is composed of two types of database management products: relational and nonrelational. These products are used to manage traditional transactions and so to support the business processes. Basically, the idea of the system is to allow the automation of data refresh directly after the execution of a transaction. More broadly, the idea is to store, manage and track real-time data business information. Such a system fulfils different functions: data security, data accessibility, data storage, data integration, … [Thiru, s.d.]

The fields touched by this system are varied, going from Customer relationships to financial, law, etc. There are numbers of enterprise-level apps that can be part of this system. For example, some transactional systems, customer relationship systems, etc. This is thus a collection of programs that manages different databases within a company. Previously, the system was dominated by SQL engines that manage the data, but now, because of the constantly evolving trends, there are many other opportunities to use an OLTP: NoSQL DBMS engines, XML databases, NewSQL databases, etc. [*OPDMS – Operational Database Management System,* s.d.], [*Inc G.,* s.d.]

b. Information systems related to administration

- **Executive Information Systems :**

The main objective of this type of IS is to provide information to the CEOs, the directors, … of companies that need to have a quick overview of the companies' performances [*Introduction et typologie des systems d'information.* s.d.]. The access to this external and internal information has to be quick and easy to understand. That is why the information is often presented using a graphical format. It generates a simplified version of the company based on the information at the disposal of the system. The main use of this system is the identification of long-term trends to support strategic planning and nonroutine decision-making. [Salem Al-Mamary & al., 2014]

For example, a director can ask for a table regarding the sales of a product in its company to see where it is positioned in the market and what are the market trends or buyer preferences. [Nordmeyer, 2019]

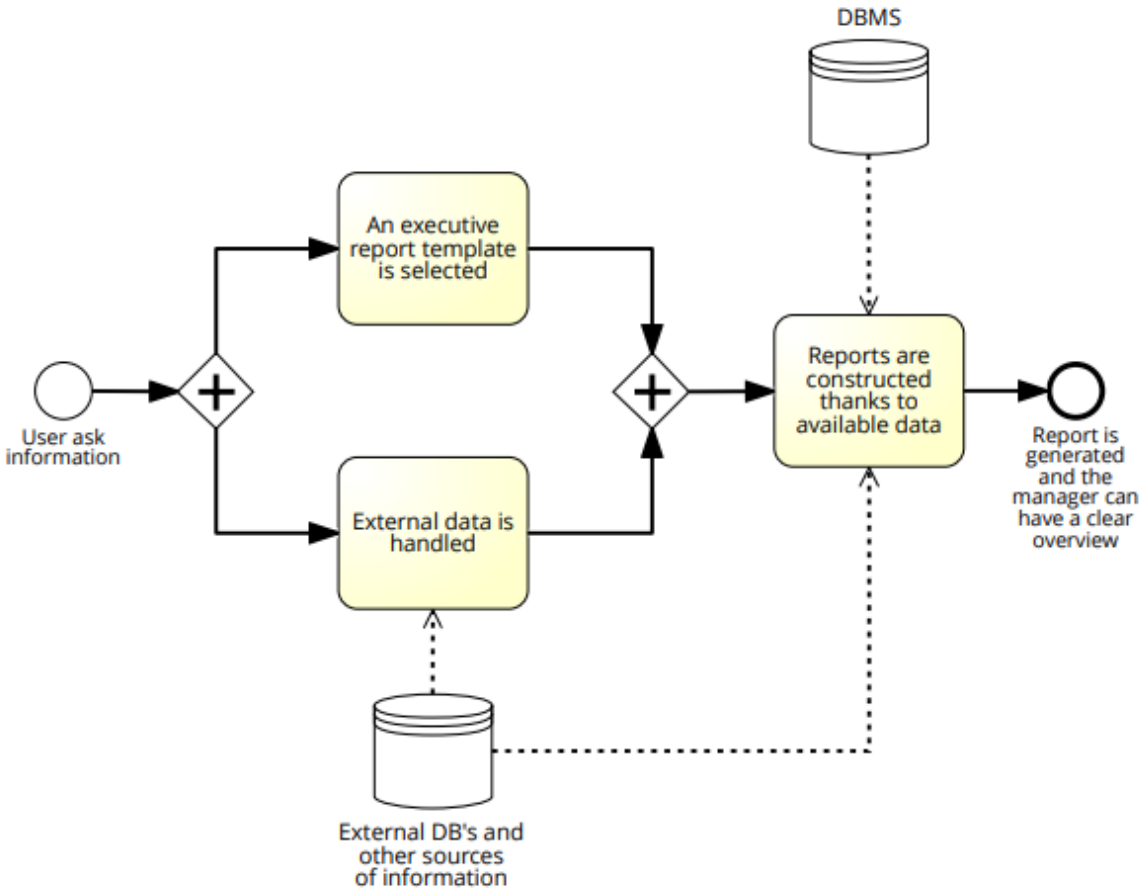


FIGURE 18: PROCESS OF THE MANAGER ASKING FOR REPORTS

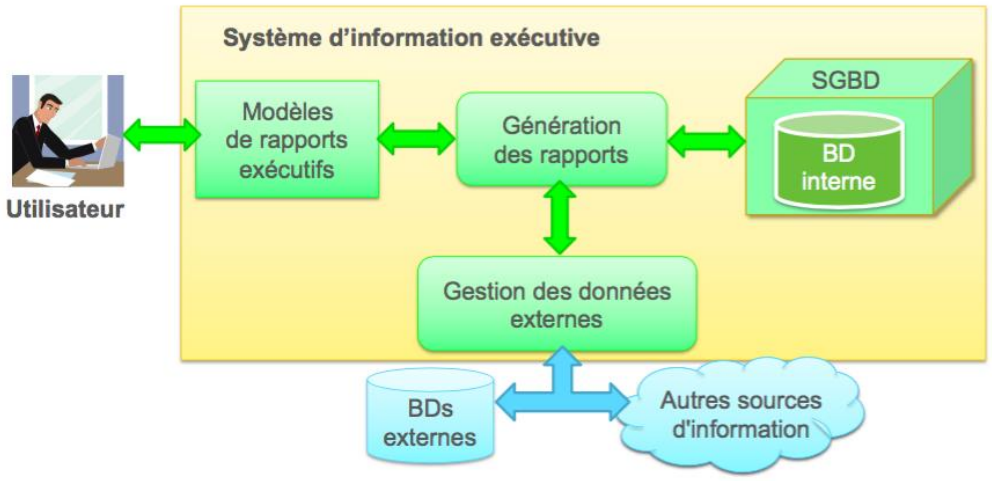


FIGURE 19: EXECUTIVE INFORMATION SYSTEM [INTRODUCTION ET TYPOLOGIE DES SYSTEMES D'INFORMATION. S.D.]

- **Decision Support Systems:**

As for the executive information, the company can ask the system to evaluate some models and to give weight to decisions that has to be taken. Such a system allows managers to use predefined or ad hoc reports to assist them in the decision-making process. Indeed, the system helps them to evaluate the possible impact of a decision before its implementation [Nordmeyer, 2019].

In other words, this system is: "A kind of organizational information computerized systems that help managers in decision making that needs modelling, formulation, calculation, comparing, selecting the best option or predict the scenarios". The system appears to be very useful when there is uncertainty regarding the outcomes. This is thus for complex decision-making processes. [Salem Al-Mamary & al., 2014]

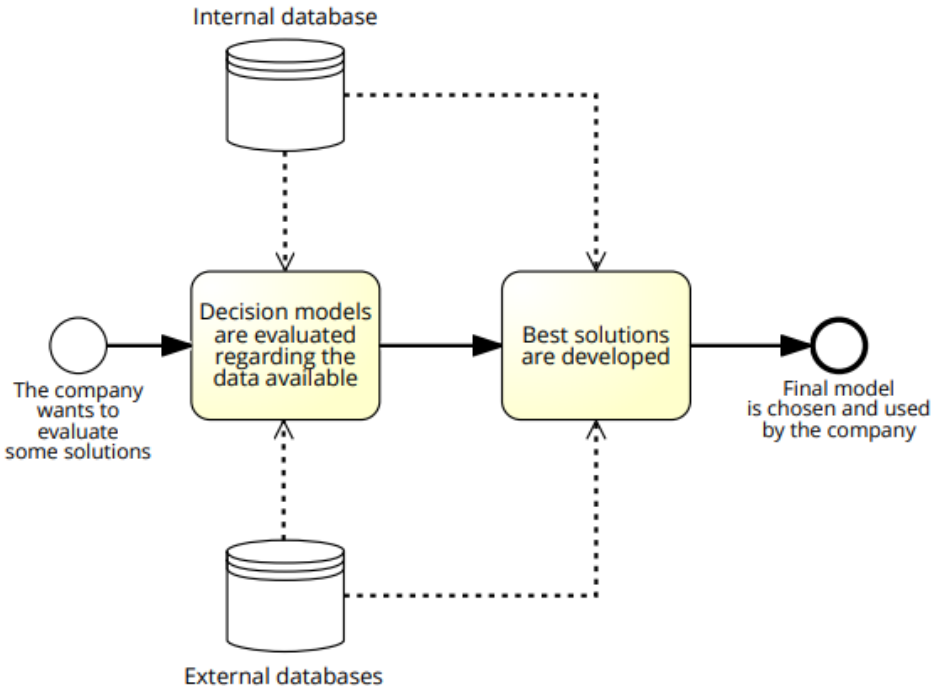


FIGURE 20: COMPANY'S VIEW USING DSS

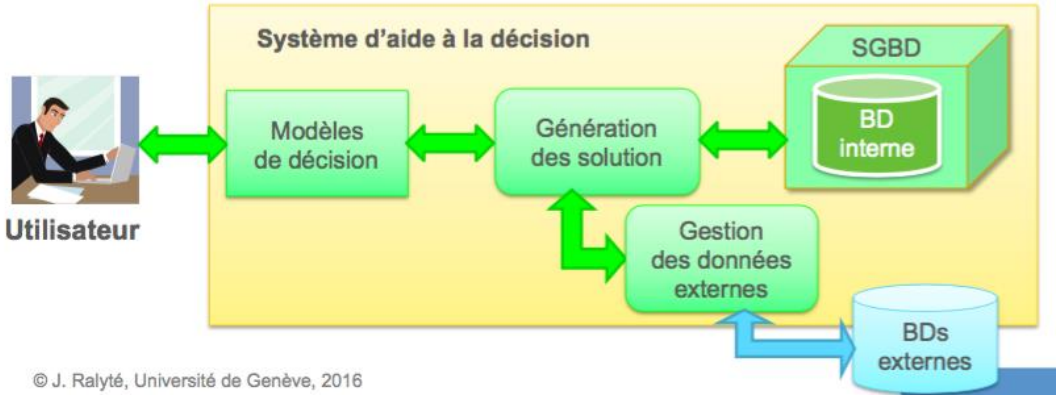


FIGURE 21: DECISION SUPPORT SYSTEM [INTRODUCTION ET TYPOLOGIE DES SYSTEMS D'INFORMATION. S.D.]

To illustrate this system, let us take the case of launching a new product. First of all, the decision-maker has to take different costs into consideration: the cost of resources, the labour cost, the promotion cost. He also needs to consider the possible profit, the current market, the competitors, … Then, he puts all the information in the system and the system will give some results. After that, the employee can modify some variables in order to see the impact on the results. After having made some modifications, the director has to take the final decision: launch of the product or not.

- **Expert Systems**:

These are decision support systems that use Artificial Intelligence. This is useful in a very particular field. Without this system, human experts would be required. Such experts are difficult to find and are expensive to companies [*Introduction et typologie des systems d'information.* s.d.]. Concretely, this is a knowledge-based system that gives advice and acts as an expert consultant. It reproduces the human reasoning. [Salem Al-Mamary & al., 2014]

- **Management Reporting Systems/Management Information Systems (MIS):**

This type of system allows directors to ask for some reports showing the performances of their areas of responsibility. The system will thus provide a report considering the form asked by the manager. That is a representation of the past and the present situation but there are no predictions in this kind of report. The system takes internal data and uses it to make a meaningful and useful report that can help to take better decisions for the company. The objective of the decision is to advance the organisation's objectives. An example of report can be the revenue made by a category of products or the evolution of the sales of a product over the time. [Markgraf, 2019], [*Introduction et typologie des systems d'information.* s.d.], [Salem Al-Mamary & al., 2014], [Nordmeyer, 2019]

Such a system brings us back to the characteristics describing Information. Indeed, when a manager wants to take a decision, he needs to analyse information that is relevant, accurate, reliable, useful, and complete (voir chapiter 3, point b). If the manager obtains information that fulfils these characteristics, the MIS can be considered as efficient.

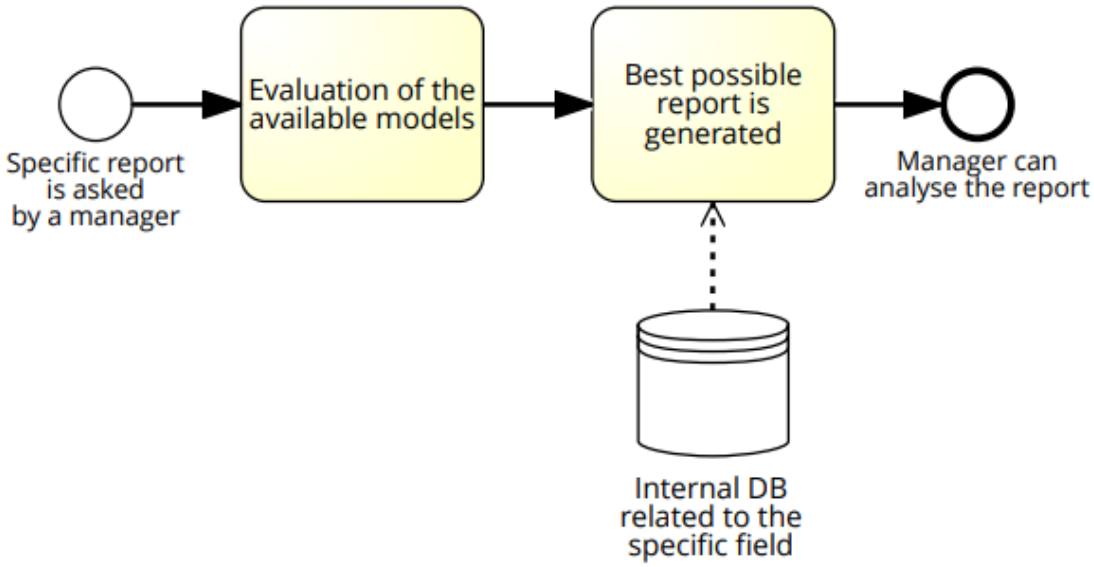


FIGURE 22: MANAGER'S POINT OF VIEW IN MANAGEMENT INFORMATION SYSTEMS

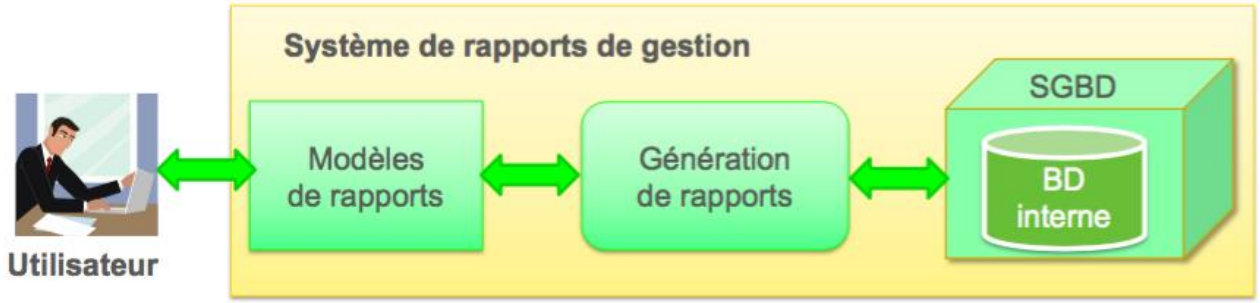


FIGURE 23: MANAGEMENT REPORTING SYSTEMS [INTRODUCTION ET TYPOLOGIE DES SYSTEMS D'INFORMATION. S.D.]

- **Human resources management Systems:**

These are systems that manage process of production, organisation, storage, and distribution concerning the manpower at various level of the company. That helps manager to take better decision regarding human resources they have at their disposal. Such a system can for example identify potential employees, track employee skills and performance, create programs that develop employees' skills, find ways to develop and train the companies' employees, … [Salem Al-Mamary & al., 2014]

- **Knowledge Management Systems:**

These systems are based on knowledge. They support the creation, organization, and dissemination of business knowledge to employees and managers throughout a company. It will allow a company to increase its knowledge. [Salem Al-Mamary & al., 2014]

c. Information systems related to production

- **Professional Support Systems :**

This is a particular system dedicated to specific fields and offering facilities needed to perform specific tasks. The worker has specific workstation which is well-adapted to his working conditions and requirements. For example, a product designer will have a touch screen, with a high quality to zoom on products, the possibility to have a prototype of its product with a 3D printer, … [*Introduction et typologie des systems d'information.* s.d.]

- **Process Control Systems:**

This kind of system allows a monitoring and control of the process (industrial or physical) [Salem Al-Mamary & al., 2014]. It is an equipment that will control the process to collect data and adapt the production if required [Murray, 2019]. For example, we can take the case of a brewery that would have sensors that analyse the beer composition to adapt the process and find the right balance in the ingredients.

- **Strategic Information Systems:**

A Strategic Information System is an information system that analyses a product or a business process and which is intended to identify what should be a strategic advantage in comparison to its competitors. It helps the company to secure a market segment due to the competitive advantage highlighted. [Salem Al-Mamary & al., 2014]

- **Manufacturing and production Information Systems/Manufacturing Execution System (MES):**

This type of system is responsible of the planning and production of the company's goods or services. It sets the objectives, the storage, the schedules, the development, the maintenance, … In general, this is a system that manages information regarding the production process. By applying computer technology, the system will increase the efficiency and improve the process, so the overall quality of the product. The overall goal is to verify the execution of the manufacturing process and increase the production performance. [Salem Al-Mamary & al., 2014], [*Manufacturing Execution Systems,* s.d.]

- **Sales and Marketing Information Systems:**

A sales and marketing information system has the responsibility to sell firm's products. The marketing process will identify potential customers, their needs, develop the products to meet the needs identified, etc. Then, the sales process will contact customers, sell the products, take the orders, … That is what this type of information system does. [Salem Al-Mamary & al., 2014]

- **Quality Management Systems:**

A Quality Management System is: "a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives". It is a tool that tries to improve the effectiveness and efficiency of an organization activities to meet customer and regulatory requirements, and, also to continuously improve its effectiveness and efficiency. [*What is quality management system (Qms)?,* s.d.]

- **Warehouse Management Systems (WMS):**

A Warehouse Management System (WMS) is a software application used by companies to keep control and track all the actions, operations and decisions taken in a warehouse every day. The purpose of the tool is to optimize the daily activities by facilitating the planning, clarifying the organisation and staff, controlling the resources allocation, utilization, and production, storing the

entrance and departure of resources, the inventory and stocks, etc. This warehouse system plays a vital role in the Supply Chain management.

These WMS exist according to different forms: the standalone system which is the "on-premises" type of WMS; the ERP module where the system will be alongside or fully integrated in thethe ERP product used by a company;a Cloud-based solution where the tool is deployed online based on the cloud technology. [Wikipedia contributors, 2021], [*What is Warehouse Management System (WMS)?,* 2016]

d. Information systems related to communication

- **Office Information Systems/Enterprise Collaboration Systems/Office Automation Systems:**

This information system is one of the most used by companies. It is a tool that helps managers to control the flow of information in companies. The aim is to help communications between members or between the company and its members. It increases the teamwork and productivity. By doing so, a company wants to improve collaboration between its members. Some examples of this system are voice mail, multimedia system or file transfer. [Salem Al-Mamary & al., 2014], [*Introduction et typologie des systems d'information.* s.d.] [Christiansen, 2021]

For example, there are project groups in a company, the group can work on the same document and they can communicate via a channel made by the society. With that, they can see the advances and they can write comments for the given project.

- **Operations Support Systems (OSS) and Business Support Systems (BSS):**

These are two tools that are complementary in their use for a company and are mainly used together with the name OSS/BSS. They are used by companies to bring support to different end-to-end telecommunication services. Both have their own data and service responsibilities. [Raynovitch, 2016]

More precisely, the Operations Support System is a computer system useful for companies to manage their networks and used by telecommunications services providers. The functions of this system are to manage network inventory, network configuration and to deal with fault management. The Business Support Systems are the components that are used by the provider to perform business operations for clients. [Wikipedia contributors OSS, 2021], [Wikipedia contributors BSS, 2020]

9. Cartography of Information Systems

After having developed a list of the different types of Information Systems, we are able to make a cartography of the existing tools that are considered as IS. In this section, different products will be discussed such as ERP, Analytics and Business Intelligence systems, Customer Relationship Management systems, etc. The purpose is to show the wide variety of available systems that are dealing with a specific field.

To do so, first the system/product/tool/software will be generally discussed with a definition of it and a presentation of its advantages and disadvantages. Then, several products providers will be presented and positioned in the Gartner Magic Quadrant. This Gartner Magic Quadrant methodology provides a graphical competitive positioning of 4 types of providers classified considering their ability to execute and the completeness of their vision, according to this Magic Quadrant, the IS providers can be "leaders", "challengers", "visionaries", or "niche players". This will be further discussed for different Information Systems. [*Magic quadrant research methodology,* s.d.]

a. Enterprise Resource Planning (ERP) systems

i. Definition

An enterprise resource planning system is a trendy information system that every company is trying to develop nowadays. Indeed, it is now considered as a "must have" in a company to manage business in the right way.

As already mentioned, this is a business management system that uses software like every information system. In this case, there is a set of software used to manage and integrate all the business functions in the companies. It is useful for a wide range of domains. For example, the ERP has business tools concerning accounting, production, sales, … That is why this system is so useful. It allows an easier flow of information between different processes of the company. According to some definition and on a theoretical point of view, an ERP can be described as "*a software that manages business processes within a company using a suite of integrated applications. The organisation can take benefit of the tool by accessing to information, optimizing processes, etc.*". It provides an end-to-end view and understanding on the business processes. To summarise, it allows companies to integrate information from various departments and optimize the concerned processes. [Wikipedia contributors, 2021], [*Definition of enterprise resource planning (Erp) – Gartner information technology glossary,* s.d.]

An example of this can be the following: A purchase order is placed, this order will be transferred to the production department, which will ask for the required materials to the department that manages that. Then, the suppliers will receive an eventual order if some pieces are missing, and the logistic department will know if they have to receive some stuffs. That is the role played by the ERP. Without that, the organisation would have to deal with each transaction separately, which increases the possible errors or omissions.

Another role that an ERP can play is the identification of performances in the process that can be increased. Thanks to that, the company can reduce its cycle time in the supply chain to produce something. Because the process is centralised with the ERP, it is easier to find where some problems are located. New solutions can be tried to optimize the process. [Shebab & al., 2004], [*Definition of enterprise resource planning (Erp) – Gartner information technology glossary,* s.d.]

ii. Advantages

An Enterprise Resource Planning has several characteristics [Shebab & al., 2004], [Linton, s.d.]:

- First of all, it automates and integrates business processes throughout organizational functions and locations. Thanks to that, the silos that are originally present in companies are more interlinked. Indeed, it allows communication and exchanges between them.
- Then, it allows a varied implementation of the business best practices with the objective to increase productivity. Data will not be duplicated in different departments; this means that teams will gain time to access the information they need. Because productivity increases, it means that both efficiency and profitability are also able to increase.
- Another characteristic is the ability to share all data and practices that are common across the entire company in order to minimise errors. Indeed, it shares information between different departments of a firm. In general, each department has its own system which creates silos in the company. When information from a given department is required, it is not always so easy to obtain it and it is a loss of time for some employees. ERP allows all relevant data to be available to all departments.
- Last, it produces and access information in a real-time environment to decrease costs and to take decision in a quicker, easier, and better way. Using ERP, information will be available to every people who might need it. For example, a manager asking for a report concerning financial results will obtain it quickly and in such a way that he will directly be able to take a decision. With the provided report, the important elements will be highlighted and thus, the decision will be easier to take.

iii. Drawbacks

The main drawback of using an ERP system is the possible project failure. Indeed, such a project requires massive investment in time, money, and effort. It requires first the implementation of the process, then the training of employees in order to use in the right way the system and the maintenance of the ERP. Because of these costs, it can sometimes be difficult for a company to deploy such a solution. They cannot afford it and the risks are too big.

Based on some studies, the price of an ERP will vary according to different elements. First of all, the size of the company will have an impact. Then, the type of Enterprise Resource Planning will also play a role. Also, the location and last, the mode of deployment. If the company goes for a cloud development, the cost can be $600 per month. For a development on the site of the enterprise, it starts at $12.000 per month. Here are the average costs to implement an ERP software in a company (However, these costs are estimation and depend on the companies' requirements) [Deskara Content Team, 2021]:

- For a small company, the cost can vary between $10.000 and $150.000.
- In the case of a medium-sized business, the cost will be between $150.000 and $500.000.
- And for a big company, the price can reach enormous amount like more than $10 million and generally starts with a lower price of $1million.

iv. Main providers

This type of system exists since many years and we can count more than 100 ERP providers in the world. Since some years, there is a big increase in the number of ERP providers. This is due to the interest of companies to adopt such systems. [Shebab & al., 2004],

Now, the trends that were observed the previous year are confirmed. Indeed, the number of enterprise resource planning systems is becoming bigger and bigger. Recently, this magic quadrant concerning cloud ERP for Product-Centric Enterprises was published (See Figure 24). Among these ERP products, some of them are often cited as best ERP providers.

Figure 1. Magic Quadrant for Cloud ERP for Product-Centric Enterprises

Source: Gartner (June 2020)

FIGURE 24: MAGIC QUADRANT FOR CLOUD ERP FOR PRODUCT-CENTRIC ENTERPRISES [CORPORATION MICROSOFT, 2020]

According to some studies and based on several criteria as integration, production features, security, pricing, etc, here is a list containing some of the best ERP systems. All these ERP software aim to fulfil the needs that have to be covered by ERP systems. They have some special features that make them unique, but the general objective is the same otherwise they will not be qualified as ERP. [*Best erp software vendor companies comparison 2021,* 2021], [Deskara Content Team, 2021], [*7 best erp softwares in 2021,* 2021], [Enfroy, 2021]

1) **Oracle Cloud ERP:**

Oracle Cloud ERP is one of the ERP products that offers solutions for medium and also for large companies. As seen in the Gartner magic quadrant, this ERP is the only one to appear as a leader in the cloud ERP field. The tool is useful for different fields like accounting, project management, supply chain management, risk management, etc.

This ERP is valuable for customers that want to adopt a hybrid ERP strategy that was previously based on an on-premises strategy to progressively switch to a cloud one. Oracle has different customers for this product. Among them, there is: FedEx, AirAsia, Blue California, Cohu, etc. [Oracle, s.d.]

2) Infor

Infor is an ERP software based on the Cloud. The variety of companies for which the product can be helpful is quite big: it goes from healthcare to manufacturing and retail. Infor solutions (end-to-end) are built with the support of Artificial Intelligence.

There are different elements that can be seen as advantages for the product. Among them, the personalization of the tool is important to mention. Infor is indeed usable on mobile devices, computers (all types of operating system), etc. Moreover, many languages are supported by the tool. Thanks to that, the collaboration between units within a company can be improved and workflows can easily be automated, …

But the tool has also some points that are missing. First of all, multi-tasking on the same computer will cause some downturns of Infor. The support is also not that good. Last, the product is not that much explicit for new users who need to learn how to use it.

The company has several partnerships that use its ERP product. There is Deloitte, AWS (Amazon), Advoco, SNS, LeanSwift and many others. [Infor, s.d.]

3) SAP:

The company SAP offers three different ERP systems. For medium-sized companies, SAP can rely on the SAP S/4 Hana tool. Then, for small and mid-sized companies, SAP proposes two products: SAP Business by Design and SAP Business One. The most appreciated product of SAP is SAP Business One. This product is mainly useful for small companies in order to maintain their growth and rationalize their processes.

SAP Business One is providing several advantages to its customers. The product is supporting the GDPR rules which is a non-negligeable point with the current trend of the society where data are more and more protected and regulated. Moreover, it offers quite a good flexibility: different operating system (iOS, Windows, Android, Linux, etc), a free trial period that allows user to evaluate the opportunities, different extensibility options and a good support system.

One of the main disadvantages is the difficulty to clearly understand the product for a beginner or first-time user. Another point to consider is the price of the tool. Indeed, the price is $94 for a complete licence, per user, per month, which duplicates quite quickly the cost.

SAP relies on several customer companies such as Toyota, Maui Jim, Sephora, etc. [SAP, s.d.]

4) Sage 300:

This product is an ERP system designed for Windows and runs on Microsoft SQL. The product is well-designed for small and medium businesses coming from different fields (distribution, chemicals, food, manufacturing)

Sage 300 offers an interesting reporting (KPI visualization, dashboards, …) and direct access to information, integration with different applications (Amazon, Salesforce, etc.). The price is quite heavy in general because it will evolve depending on the number of user accounts, the needs, functionalities, personalization, … required by the company that will use Sage 300.

Sage300 can count on several customers too. Amongst them, there are Kobayashi, Empire Candle, Costa Farms, Palmer Holland, Novavax, etc. [Sage, s.d.]

5) Dynamics 365 ERP:

Dynamics 365 ERP composes the ERP part of the Microsoft Dynamics solution. More than only an ERP, this product also provides a Customer Relationship Management tool.

On one side, using Dynamics, a company will be able to see clearly its KPI's and issues faced. A company will also be able to have a high level of customization for these tools and its data will be secured. Also, the tool is compatible with a lot of platforms. On the other side, the tool is does not offer a good support and there is no free trial period offered.

The main users of the tool are Dynamics 365 has Pandora, HP, Coca-Cola, Crate&Barel, Unicef, Dr.Martens, BMW among others. [Corporation Microsoft, s.d.]

6) Oracle NetSuite:

This product is not considered as only an ERP one. Indeed, Oracle NetSuite is defined as an "all-in-one business management suite that encompasses ERP applications, financials, CRM and ecommerce".

So, the product allows automation thanks to integration of processes that are not visible. Moreover, the solution appears to be very flexible and customizable, is often upgraded, provides excellent support, etc. But the Oracle NetSuite is only available on cloud, the support seems to receive a lot of complaints and the upgrades of the tool are not always easy to get.

Oracle counts a lot of customers given the number of solutions the company proposes. Therefore, we can cite TOV, YouGov, Jollibee, The Boston Globe, Automation, etc. There are customers in various fields such as Retail, Manufacturing, Distribution and Wholesale, Food and Beverage, and many others. [Netsuite, s.d.]

7) Epicor ERP:

This software is a fully integrated end-to-end ERP solution designed and dedicated to support growth and to adapting to the situation. Thus, the tool can be useful for a variety of situations because of the flexibility of its modules, including features and functionalities. Thanks to that, Epicor ERP are useful for HR management, supply chain management, Business Intelligence, customer relationship management and many other fields. Epicor is the most used in medium size companies which seem to be the best fit.

The brand relies on several advantages. First of all, the solution is highly customizable. Indeed, it is possible to choose for a cloud or a on-premises solution, it is possible to use it on iOS, Windows, Linux or Android. Also, a company can choose only the features/functionalities it requires. Then, Epicor offers a very good support for its customers via phone calls, tickets, or live chat.

On the other side, some drawbacks can be highlighted. First, Epicor is only available in English and the tool does not support any other language. Then, regarding the financial aspect, you must be sure that you want to work with Epicor because it does not offer any free trial.

Epicor presents different customers. Among its clients, there are: Aaron&Company, Acadian Ambulance Service Inc., Air Techniques, etc. [Epicor, s.d.]

8) IFS:

IFS is an ERP provider that is mainly used by medium and large companies. The tool can be deployed either in the cloud or on-premises. Solutions are proposed for companies such as aerospace and defense, utilities and resources, construction, and infrastructure, etc. To summarize the product, it is mainly useful for projects that combine different elements such as manufacturing, service, asset management given the ability to custom the tool.

IFS, as a French ERP provider, relies on some companies as customers. There is Aston Martin, Carlsberg, Panasonic and De Havilland Aircraft of Canada Limited. [IFS, s.d.]

b. Analytics and Business Intelligence (ABI)

i. Definition

According to Gartner glossary, Analytics and Business Intelligence is: *"An umbrella term that includes the applications, infrastructure and tools, and best practices that enable access to and analysis of information to improve and optimize decisions and performance"* [*Definition of analytics and business intelligence (Abi)—Gartner information technology glossary*. s. d.]. In other words, the idea of such a tool is to gather, analyse, filter and sort information to have the best one available to take the best possible decisions for companies. Thanks to past and present data, statistics can be performed, and analysis can be run to have outputs from raw information for future decisions. Basically, these tools will give value to data and transform it into information. [Durcevic, 2018]

For the moment, there are discussions to find the clear difference between Analytics and Business Intelligence. Most of the experts agree that these two domains are very connected. To differentiate the two, we can highlight the fact that Analytics put more emphasis on prediction and modelling of the future while Business Intelligence is more concerned by the current moment of the data to take the best possible decision for the future. Concretely, Business Analytics is putting emphasis on the "why" something happens when Business Intelligence is busy with the "what" and the "how". [Durcevic, 2018]

ii. Advantages

Based on the definition mentioned in the previous section, some advantages can be defined concerning Business Intelligence and Business Analytics tools. Indeed, thanks to the analysis performed by them, a company is able to make different things [Durcevic, 2018]:

First of all, because of the information created by the tools, the firm will be able to boost its profit. By having a deeper analysis of processes, the firm can choose the best possible solutions and so, the revenues are maximized, all optimized from a timing and economic point of view.

Secondly, it is important to note that the analysis processes are fully automated once the tool is implemented. Based on that, the company will just need to update its tool if required and use the information provided.

Thanks to that, the firm will have a better overview of its health and will also have a much better understanding of its customers because some trends can be highlighted. Indeed, if the firm sees specific results thanks to analysis, it will be able to adapt its offering.

This leads to the next advantage: The Unique Value Proposition of a company using ABI tools will be stronger. The firm will be able to react to changes on the market quicker thanks to the analysis and the firm will also be able to understand the "what", "how" and "why" the changes are coming.

iii. Drawbacks

On the other side, as for everything, there are some disadvantages considering Business Intelligence and Analytics products. These elements can be considered more as limitations for the moment, given the fact that the tools are constantly evolving. In the future, some of these issues will certainly be solved. [Kumar, s.d.], [Danziger, 2020]

First, the cost of implementing such a system can be repulsive for small companies. On top of the software cost, you need to consider the cost of the team that will work on it. The starting cost can be too high for some firms despite the big return on investment (ROI) guaranteed by ABI tools. Moreover, the ROI will not be immediate, this is a long-term perspective.

Other concerns are data privacy and breaches. Indeed, some information considered as confidential or important for the market can be shared between companies for mutual benefits, which is something that can be dangerous for others. Moreover, some data must be anonymized or kept secret in some companies to avoid privacy issues. Rules are defined to protect consumers and companies for the moment, such as GDPR, but this is not always enough.

One other disadvantage is the data quality issue that companies can face. Nowadays the volume of data is growing all over the world with a potential negative impact on the data quality. If a system uses data of poor quality, the performance will not be optimized. That is why the data sources must be verified before taking any decisions.

A last limitation concerning Business Intelligence and Analytics systems is that customers can sometimes still be reluctant to adopt these tools. Some departments within a company appears to be against the adoption of these systems. Different reasons can be discussed: the complexity to understand the tool, the fear of change, the impression of losing control, etc.

iv. Main providers

As for the ERP, there is an increasing number of ABI system providers. This is also a trendy system that is more and more used in companies. Some ABI providers will be described in the following section based on the Gartner graph published in 2021 concerning the positioning of different brands on the market,. [*Top 52 business intelligence companies in 2021,* 2020]

FIGURE 25: MAGIC QUADRANT FOR ANALYTICS AND BUSINESS INTELLIGENCE PLATFORMS [MICROSOFT, 2021]

1) Microsoft:

As a Business Intelligence and Analytics software, Microsoft is a leader in the domain and is composed of different parts: Microsoft Office – Excel, SQL Server, SharePoint, Microsoft Azure and finally Power BI. Each product has a special functionality. First, Microsoft Excel is useful to allow users to see and, in some extent, analyse data. Second, SharePoint allows users to collaborate, share, manage documents in a secure environment built by companies according to their needs [*Qu'est-ce que SharePoint?*, s.d.]. Then, SQL Server is used to control, manipulate, sort out and even update data using SQL language [*SQL Server,* s.d.]. Azure is a cloud platform where users are able to perform different activities such as analytics, virtual computing, storage and networking [*Microsoft Azure Explained,* 2019]. Last, Power BI is the tool dedicated to the reporting aspect where you show the information based on the data collected. This is a cloud software where users can build their own

reports and manage who will be authorized to see the reports that are interactive. The tool does not require strong technical skills and so, is known as a quite intuitive tool [Why Power BI, s.d.].

Some of the customers of this company are Metro Bank, Miami Heat, Montfort, RollsRoyce, Heathrow, WorldSmart, etc. [Power BI, s.d.], [Business Intelligence tools, s.d.]

2) Tableau

Tableau is another product that provides Business Intelligence and Analytics solutions for people who require it and is considered as one of the leaders in this field. This brand is based also on different data visualization products and is available using desktop, server, public and online. The product is described by the firm as an intuitive one where you receive a non-limited opportunity to explore data. As in Power BI, Tableau offers opportunity to see very clear visuals and rely on a strong community to help its users. Tableau is based on drag-and-drop to create visuals and explore them using the available data. [Tableau, s.d.]

The company has also several customers. Among them, we have Dubai Airports, Charles Schwab, Whole Food Market, Verizon, Red Hat, Specialized, … Here again, you can see the variety of companies using Tableau and so, an ABI product. [Customer stories-Tableau, s.d.]

3) Qlik

Qlik is considered as the third leader in the Gartner magic quadrant for this year. Qlik is composed of two products which are called QlikView and QlikSense that allow Business Intelligence but also Data Visualization. So, as for the previous brands presented, the idea is to transform raw data into meaningful information that is used by companies to take better decisions. Moreover, Qlik allows its users to make associations and discover information. For Qlik, the list of customers is the following: Lloyds, NHS, PayPal, Airbus, HSBC, Novartis, etc. [Qlik, s.d.]

4) SAS

SAS is also providing some solutions to make Business Intelligence and Analytics. Indeed, the brand proposes an integrated, robust, and flexible display screen to analyse statistics, predictions, data and text mining. In addition to allowing analysis, it is also possible to run queries using SAS which is an interesting point of the tool. [SAS Enterprise bi server in 2021, 2018]

To cite several SAS customers, there is TDWI, SeacoastBank and Vecima Networks. [Business intelligence & analytics software, s.d.]

5) SAP

SAP is not only an ERP. It also provides useful tools to perform some Business Intelligence and Analytics activities. Here, SAP is composed of different software that provide BI solutions and is cited amongst the Visionaries by the Gartner magic quadrant. There is SAP Business Objects BI Suite, SAP Lumira, SAP Crystal Reports, etc. Through the SAP Business Technology Platform, some objectives are indeed to provide real-time insights using BI and Analytics. Artificial Intelligence, Machine Learning, … are also fields that are considered in this suite of tools. As for other tools discussed in this section, the overall objective of the BI & Analytics tools is to provide meaningful reports for the company that needs them for decision-making processes. [SAP, s.d.]

As for the ERP part of SAP, there is also a list of customers that can be mentioned for the BI and Analytics software of SAP. Porsche, PWC, Randstad, Gates, … are among the SAP customers. [SAP, s.d.]

6) IBM

IBM also provides solution more especially in the Analytics field. There are different topics managed by the firm. First, there is the option to build a virtual assistant using Watson Assistant tool. Then, it is also possible to analyse your data and identify trends using the IBM Cognos Analytics tool. With the IBM Cloud Pak for Data, a company will be able to have a better view and to bring together collections and analysis of data. Last, using IBM Planning Analytics, processes will be automated (plannings, budgets, forecasts). In addition to that, there are also tools that allow to use SQL to mine data, tools to manage security, identify threats, etc. [IBM, s.d.]

Among some of the customers that are using IBM services, we have Anthem, Fortis Healthcare, Iptor, etc. [Client stories, s.d.]

7) MicroStrategy

As the other brands, MicroStrategy is known in the BI field for providing dashboards that allow companies to display their data using beautiful visuals. They are easier to analyse and understand than simply having a view on the data. On top of providing interactive dashboards, MicroStrategy also offers scorecards, reports that can be formatted in the way the user wants to, queries, etc.

MicroStrategy has several partnerships with customers that are well-known such as Pfizer, Disney ABC, ServiceNow, Visa or eBay. [MicroStrategy, s.d.]

8) Board

Board, amongst the ABI tools, is seen as a Niche tool which means that it is dedicated to a specific part of the users. Board describes itself as the world number one to take decisions by having the full control of your plans and performances. Using Board, the view of a company will be complete, and the company will have processes completely integrated. Based on that, the tool fulfils three things: Business Intelligence, Performance Management and Advanced Analytics. [Board, s.d.]

As principal customers, Board presents Mitsubishi Electric, KPMG, Puma, Coca-Cola, and United States Navy. [Board, s.d.]

c. Customer Relationship Management (CRM)

i. Definition

As mentioned in the previous section (7. Types of Information Systems), CRM is a software that can be used in different situations [HubSport, s.d.]:

- In a situation where you have the right number of customers, it manages interactions with customers, proposes a follow-up based with an overview, and other actions useful in this context.
- In the situation where you do not have enough customers, the CRM tool can be useful to contact new potential customers according to marketing campaigns, newsletters, etc. So, it will try to attract new customers based on data, trends, etc. All these actions can be performed in an automated way, which is why they are used in companies.

ii. Advantages

Different elements can be mentioned as advantages for a CRM. First, such a software can be used in different scenarios. Indeed, it can manage both situations: a situation where the number of customers is sufficient, and, also a situation in which there is a need to attract more customers. This

seems profitable for every company. Second, it allows the process to be automated. This is very interesting for companies because it will save time, money, and effort. Therefore, productivity and efficiency will increase. Thanks to the personalization of the messages sent, of the campaigns, … the customer experience will also be improved by the CRM software. All these elements also lead to a concluding advantage: companies will increase their revenues using CRM software. [Thakral, 2021], [Sowards, 2019] [SAP Insights, s.d.]

iii. Disadvantages

Concerning the use of CRM tools in companies, some drawbacks are identified. [Thakral, 2021], [Sowards, 2019]

First, the staff can place too much confidence in the tool. This can be dangerous in case of failure or in case of brutal change in customers preferences.

Second, because of the centralization of the data, there can be some risks concerning data security and data protection. But nowadays, these systems are getting much better protected than before.

Last, as for every Information System, the implementation cost and the time between the launch of the project and the noticeable effect of the investment are elements that threaten CRM software also.

iv. Main providers

Based on the Gartner magic quadrant graph that appears in Figure 26, here is a presentation of the companies that provide CRM software in the way of Customer Engagement Center. On the other graph (see Figure 27), here are the best CRM software in term of Lead Management. It appears that most of the CRM software are present on both graphs, but some of them are only targeting one specific field of the CRM which makes them more unique in the domain.

Figure 1. Magic Quadrant for the CRM Customer Engagement Center

FIGURE 26: MAGIC QUADRANT FOR THE CRM CUSTOMER ENGAGEMENT CENTER [PEGA, 2019]

Figure 1. Magic Quadrant for CRM Lead Management

Source: Gartner (August 2020)

FIGURE 27:MAGIC QUADRANT FOR CRM LEAD MANAGEMENT [ORACLE, 2020]

1) Salesforce:

The company describes its software using the following sentence:" *We bring companies and customers together*". Based on that, it clearly appears that Salesforce is a CRM tool. The idea of Salesforce, which is perceived as a leader on both CRM Lead Management and CRM Customer Engagement Center is to provide a unique experience to customers. More precisely, it will attract new customers based on personalized marketing campaigns. To make personalization, Salesforce has the ability to clearly analyse and understand the needs and fears of customers. Then, the tool is known as a fast one to respond. Last, the operations are automated and customized. Another strength of Salesforce is that it is compatible with both small and big companies. Among them, we can cite Perkbox, rated people, Aston Martin, Virgin, U, etc. [What is Salesforce?, s.d.], [Salesforce, s.d.]

2) Pegasystems

Pega is a brand that also provides a CRM tool. However, as seen in both graphs, Pegasystems is only focusing on Customer Engagement. The tool relies on an Artificial Intelligence and automation

tools that are very useful to attract new customers. These elements allow Pega to offer a personalized marketing, an accelerated sales process, and a new customer experiment. [Pega, 2018]

Some customers that are using Pega are the following: CommonwealthBank, GreatAmerican Insurance Group, Santander, Cisco, DellEMC, etc. [*Tous les clients | Pega,* 2018]

3) Freshworks

Previously known as Freshsales, this CRM tool is dedicated to different aspects of the CRM. Indeed, it appears in both graphs. Freshworks describes its CRM tool as: *"a single source of truth for your business and provides a 360° view of your customer, by capturing and combining customer experiences in one place"* [Freshworks crm, s.d.]. The main difference compared to some other CRM is that Freshworks combines all activities in a single tool. A team can use it for different actions: AI evaluation of opportunities, email, activity registration and analysis, phone, etc. [Freshworks crm, s.d.]

This CRM allows a large customization in addition to a productivity increase thanks to automation processes and communication improvements because of the various contact points available. This CRM effectively supports multi-language and multi-currency which is very interesting for big companies located in different countries. Moreover, the interface is highly customizable (text, date, list), and allows to display what you want to see and to personalize it. Last but not least, Freshworks offers the opportunity to follow customers through the whole lifecycle which means that there has been a follow-up of the customer since its arrival in the company (or even before) and efforts are made to keep it as long as possible in the process. The company seduces several customers among Posti, fiverr, Eastern Washington University, Pearson, Springer Nature, etc. [Freshworks crm features, s.d.], [Freshworks inc., s.d.]

4) Zoho

Same as Freshworks, Zoho is present in both Engagement and Lead Management of CRM. Thanks to that, the software has also quite the same characteristics: it increases the ways to communicate with customers, it increases the processes efficiency because of the task's automation, it provides customers information quickly, it uses Artificial Intelligence to help decisions processes regarding customers, etc. Among Zoho's customers, we can include Netflix, Bose, Suzuki, Purolite, hotstar, Abu Dhabi Aviation, etc. [Zoho, s.d.]

5) SAP

SAP is already mentioned as an ERP provider and a Business Intelligence and Analytics provider too, but it seems also to be a company active in the CRM domain. In this field, SAP provides different solutions: e-commerce, Customer Data, Sales, Service and Marketing. These are the SAP Customer Experience solutions. On a more general point of view, the SAP CRM tool provides quite the same solutions as the other tools presented before. [SAP, s.d.]

Here again, SAP relies on some customers for this product. They are not always the same as for the other products. The customers for SAP CRM software are: Daimler, Valero Energy Corporation, Electrabel, ICBC, EDF, etc. [World A.R.T., s.d.]

6) Adobe

With Adobe Experience Cloud, a company is able to manage its customer experience in the best possible way. This means that the software is only dealing with the second graph, Lead Management, concerning CRM tools. Indeed, by putting emphasis on customer experiment, Adobe

does not try to attract new customers, but only to keep the existing ones into the company using its software.

Adobe's offer is aimed to create the best possible experiment. First, they provide an access to customers information in real time to personalize experiment and adapt your offering. Then, the tool offers the possibility to create messages over different channels and on a large-scale perspective. In addition to that, Adobe is the only company that is aware of the needs to use more than one software to be as complete as possible. Therefore, Adobe Experience Cloud is compatible with other brands [*Gestion de l'expérience client,* s.d.]. For example, they promote the fact that combining Adobe and Microsoft Dynamics 365 CRM should be the optimal way to manage Customer Relationships. [Adobe & Microsoft Dynamics 365, s.d.]

Among the companies using Adobe CRM product, there are: Auchan, Amplifon, Philips, TF1, Silversea, etc. [*Témoignages clients | Adobe,* s.d.]

7) HubSpot

HubSport CRM software is the only one that is known as a free software. However, some more advanced features are only available using a "pro licence" which means cost for a company. It is built to manage the leadership. The software proposes different actions. Firstly, it automates processes such as a company will not have to manually updates reports and data. Secondly, it allows salespeople to gain time by providing sales productivity tools that are useful to increase sales without having to work more. Thirdly, despite not being visible on the first graph, HubSpot offers the opportunity to reach both existing and new customers through some mails, … Lastly, the tool provides an opportunity to structure company's communication and to orient its members towards the customer. Based on this, HubSpot presents several customers for its tool: Atlassian, Doordash, Invision, Purple and Wistia are among them. [Hubsport, s.d.]

d. Operational Database Management Systems (OPDMS)

i. Definition

As mentioned in Section 7, an OPDMS is an Information System used to modify in real-time data in a database after the performance of some transactions. More especially, the system tracks, follows, modifies, and updates the databases that are used by companies.

From an external perspective, this system acts like a bridge between users and databases. Its idea is to transform user requests into meaningful instruction for the database so that operations can be performed. Because of this link created by the system, the database complexity is not that visible for users. [*What is DBMS?*, s.d.]

A special category for this system is the Cloud Database Management System. This is a specific Operational Database Management System dealing with databases in cloud storage. As the general system, the Cloud system has the same objective: manage data and allow analytical processes to be performed in an easier way than without the system. [Inc G., s.d.]

ii. Advantages

Using such a system presents several advantages, especially regarding the data. Indeed, the implementation of an Operational Database Management System allows companies to avoid data issues. [*What is DBMS?*, s.d.]

First, by creating a platform where the data is stored, the companies are providing an easy access to data to their employees. It is thus easier to retrieve useful data, to find the right data, to share data, etc. So, data sharing and data access are improved.

Secondly, despite providing access to a lot of people, using a Database Management System allows companies to believe that their data is in a secure environment. The system will be protected against intrusions. Moreover, thanks to the better management of the system, the data will be well-integrated, and this will allow a better understanding of the organisation activities.

Third, thanks to the real-time updates which are fully automated, the data suffers less from some wrong manipulations. The Operational Database Management System brings more data consistency.

Because of these improvements regarding data management, two additional points must be mentioned. At first, having a well-managed database allows users to increase their productivity. They will save time for different activities: data sharing, finding data, update data, etc. Then, the data management will also allow them to have a better overview, to generate more relevant information and therefore, to take better decisions. [*What is DBMS?*, s.d.]

iii. Disadvantages

Despite having many advantages, this system also presents some disadvantages. As for all the others, both implementation and maintenance represent a certain cost for companies that is not negligeable. It also requires personal that has specific skills.

Then, it is required that the employees understand how to use the tool and go all in the same direction. Otherwise, the implementation will be useless for the company and will just represent a loss.

Because the world we are living in is moving fast, it is clear that companies selling these systems perform a lot of upgrades, modifications and launch new products. This means that companies having implemented such systems will face a lot of replacement, upgrades, or modifications too. [*What is DBMS?*, s.d.]

iv. Main providers

The magic quadrant made by Gartner concerning the Operational Database Management Systems of 2019 is also listing the most interesting providers, (Figure 28). Here again, the quadrant is composed of four sections: Leaders, Challengers, Visionaries and Niche players. In the quadrant, we can see companies that have already been discussed in previous sections (ERP, CRM, etc). This means that the interest in building a suite of Information System exists for some companies.

Moreover, a second graph (Figure 29) concerns only the Cloud Database Management Systems. It sorts out that most of the brands mentioned in the first graph also appears in the second one. This means that most of the OPDBMS are in fact Cloud systems. This is very easy to understand because we are more and more using these technologies and companies are migrating to cloud technologies as well as this makes these systems more popular. [Gartner, s.d.]

Figure 1. Magic Quadrant for Operational Database Management Systems

Source: Gartner (November 2019)

FIGURE 28: MAGIC QUADRANT FOR OPERATIONAL DATABASE MANAGEMENT SYSTEMS [GARTNER, S.D.]

Figure 1: Magic Quadrant for Cloud Database Management Systems

Source: Gartner (November 2020)

FIGURE 29: MAGIC QUADRANT FOR CLOUD DATABASE MANAGEMENT SYSTEMS [AMAZON WEB SERVICES, 2020]

1) Amazon Web Services (AWS)

Amazon Web Services (AWS) is considered as a leader in both Operational and Cloud Database Management System. The platform proposes more than 200 services for companies and is built to fulfil needs of enterprises or individuals. Concerning the databases, this platform allows to perform multiple actions like calculations, data storage, database creation, … but also proposes new technologies such as data lake, machine learning, blockchain, etc. This is thus a very trendy platform that proposes innovation and is adapted to a lot of potential customers' needs. Amongst its strengths, we can cite the fact that it is providing the biggest number of databases to fit perfectly with what is needed by the customer. Moreover, AWS ensures a high security level that can protect military data, international banks data, … [Amazon Web Services, s.d.]

The most popular services provided by AWS are:

- **Amazon Elastic Compute Cloud** (EC2) which allows a scalable deployment of applications. Indeed, the product provides a web service where you can make different things with a minimum of required effort. Using this, you are able to run apps in the informatic environment provided by Amazon. [AWS | Amazon EC2, s.d.]

- **Amazon Simple Storage Service** (Amazon S3) is a service that allows to stock objects. This provides security, evolution, availability, and performance. Amazon S3 provides way to manage your data and control them quickly, efficiently and in the right way regardless the size of the data that must be stocked. [AWS | Amazon S3, s.d.]

- **AWS Lambda** which is an Extract-Transform-Load tool (ETL) that allows to run code without having to handle server. Indeed, an ETL is defined as follow: "The general procedure of copying data from one or more sources into a destination system which represents the data differently from the source(s) or in a different context than the source(s)" [Wikipedia contributors, 2021], [AWS |Lambda, s.d.]

AWS has several interesting customers impressed by its polyvalence and using different services provided by the platform. There are Expedia, that wishes to migrate 80% of its applications in the Amazon Web Services, Intuit that deploys solutions quicker using AWS, Shell using the tool to avoid data breaches, Siemens, Brooks Brothers, etc. [Etudes de cas | Amazon Web Services, s.d.]

2) Microsoft:

As an Operational Database Management System provider, Microsoft proposes several tools that fulfil this role. There are Microsoft SQL Server and Microsoft Azure (SQL Database, Document DB, Cosmos DB, Database for mySQL, etc).

Microsoft SQL is described as a scalable data platform composed of different tools. First, there are Extract-Transform-Load tools (=ETL). These are tools widely used in data integration processes. The tool performs three actions: it collects data from a data source, then it will transform the data into the required format and last, the data will be loaded into a new data source asked by the user [*What is extract, transform, load?,* s.d.]. Second, there are reporting tools that are useful to understand and create information based on the data available. In Microsoft SQL, data can be modified, added and queried using the SQL language. Microsoft SQL has some customers amongst Hiscox, Systems Imagination, Baltika and dr foster. [*What is mssql?,* s.d.] [SQL Server 2019, s.d.]

Microsoft Azure, for its part, is a cloud platform composed by several services (more than 200). This platform proposes thus solutions that are comparable with the Amazon Web Services platform. A lot of things can be done using Azure: building apps, store data, find data, modify, create, etc. Among its customers, there are Asos, Daimler or McKesson. [*What is Azure?,* s.d.]

3) Google:

As well as Microsoft and Amazon, Google provides a Cloud Database Management System. Here again, the Google's platform is made of different elements and is recognized by Gartner as a leader in this field. Google describes its platform as a way to: "*Transform your business with innovative solutions*". The solutions provided fit for different types of companies and different types of challenges. As for others, using Google databases will allow a company to perform several actions: migration, modernization, and transformation. [Google Cloud, s.d.]

The most famous customers of Google in term of database management are ShareChat, The New York Times, AutoTrader, Twitter, Sky, Carrefour, etc. [Clients | google cloud, s.d.]

4) Alibaba Cloud:

Alibaba company is leader in cloud and Artificial Intelligence and appears as a challenger in OPDBMS. The firm provides “reliable and secure cloud computing and data processing capabilities as a part of its online solutions”. [AlibabaCloud, s.d.]

Alibaba has several well-known customers using its cloud services. There are: Olympics, Ford, IHG, Cathay Pacific, Garuda Indonesia, etc. [*Customer success stories & case studies-Albibaba cloud,* s.d.]

5) MarkLogic:

MarkLogic appears, according to Gartner studies, as a visionary concerning Database Management System. By using MarkLogic Data Hub Service, a company will be able to do different things: integration, maintenance, etc. All these actions will create business value which is what companies are looking for when they use these tools. In an organisation divided in several silos, MarkLogic will have a direct impact by implementing fast pipelines between them. This means that the company will not have to implement and use complex ETL systems. This is thus a simple link between the silos. Moreover, these pipelines will create a unified platform that can be considered as a single database. This will allow quicker modifications, quicker creation, and quicker access. In addition to quicker performances, the tool also guarantees some data security. To summarize, actions will be performed in a more efficient and simpler way, and also with security behind the process. [Data hub - MarkLogic, s.d.]

MarkLogic has convinced several companies to rely on its services: AbbVie, Sony, Warner Bros, Northern Trust, J.P. Morgan, etc. [MarkLogic, s.d.]

6) Neo4j:

Neo4j is an open-source and noSQL graph database management system. This means that the tool is not only focus on storing and managing the data, but the idea is also to manage relationships between the data. The objective is to show how data interacts without defining a model to stick your data to. By doing that, the tool is very flexible when there are modifications brought to the data stored. Indeed, the graph can quickly change because there is not a clearly defined model. In addition to that, by using such an approach, Neo4j avoids doing several operations to connect data together (Join operations, …). Moreover, Neo4j is not using SQL language but Cypher, which is similar but way more efficient for graphs.

This structure is composed by different elements: Nodes which are entities of the graph and Relationships which connect elements. In such a structure, data can be stored in either the Nodes or the Relationships. [Neo4j Graph Database Platform, s.d.]

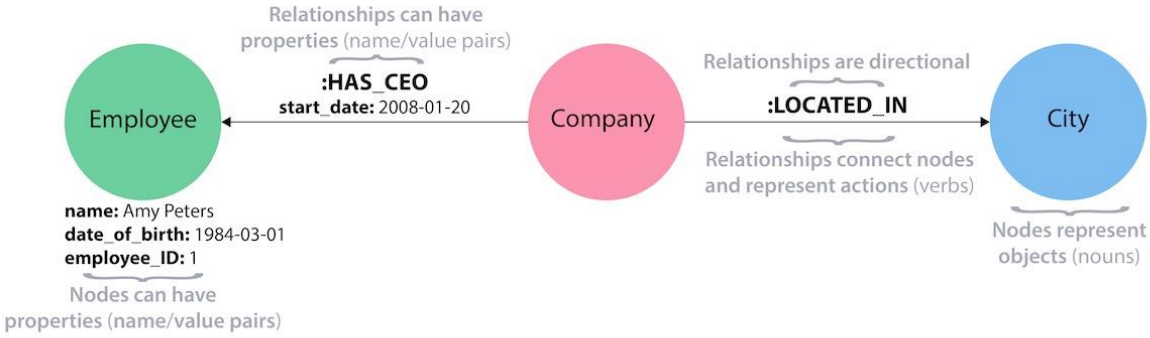


FIGURE 30: GRAPH DATABASE STRUCTURE [NEO4J GRAPH DATABASE PLATFORM, S.D.]

Among the companies using Neo4j to store, manage and secure data, there are: Current, Levi Strauss&Co, Allianz, UBS; ComCast, etc. [Neo4j customers, s.d.]

7) Huawei:

In a wish to extend its activities and to challenge rivals, Huawei has launched a Database Management System. The idea of the system is to provide an opportunity to migrate database to the cloud using Huawei Cloud products. Based on that, companies will be able to reduce their costs and to have an increased and easier access to its data. The overall objective is thus to get a quicker digital transformation for companies relying on the Huawei tools. [Huawei, s.d.]

The best Huawei's customers are African Union, Alestra, Avacon, Johan Cruijff Arena, Bank of China, Caixa, etc. A lot of customers are from Asian regions for Huawei. [Featuredcustomers, s.d.]

8) Databricks:

Databricks is located by Gartner in the visionary part of its graph. There are several functionalities provided by the company [Databricks, s.d.]. First of all, it allows to retrieve all your data, regardless the format, source, type and the quantity. Then, the tool is an opportunity to build pipelines between different elements in order to have better connections between them. This can be easily managed using Databricks which supports several programming languages: Python, R, Java, etc. Third, the tool is useful to build data lakes. This is a way to store data when you are dealing with the field called "Big Data". In data lake, data is not modified or at least not that much transformed to store data in the quickest and most efficient way possible. [*Data Lake: Définition et guide définitif,* s.d.]

Databricks counts on several customers including Regeneron, H&M, HSBC, Biogen, CVS Health, etc. [Success stories, s.d.]

e. Warehouse Management Systems (WMS)

i. Definition

As mentioned in the Section 7. Types of Information Systems, a WMS is a system developed and used by companies to keep control, view, and track all the actions, operations and decisions taken in a warehouse on a daily basis. The system can be deployed according to different opportunities that can be either on hardware or on the cloud. Moreover, this IS can be deployed as a standalone Information System or be part of another one, like being a module belonging to an ERP product.

ii. Advantages

As it brings support to different activities performed in a warehouse, such a system presents several advantages. First, a WMS allows a better understanding and view on the inventory level in real-time. That is due to the direct updates when an action is performed. Thanks to that, the supply chain is better managed, and the company faces less risks off running out of stock.

Secondly, this also creates an overview of the inventories, decisions, … that are taken in the warehouse. So, everything appears clearer concerning the warehouse management. Thanks to the increased visibility, a company is also able to better communicate with customers concerning some orders status or stock level. This is useful to give guarantees to customers. In fact, everything will be better coordinated. [Pruszynska, s.d.]

In general, as for every system discussed, an advantage is that the system will cause a less important cost to manage the activities. On a long-term perspective, the system will allow the company to gain time because of the automated processes, which means that the company will be more productive, and so will gain money. [iThink Logistics, 2019]

iii. Disadvantages

Concerning the points that can be improved for such a system, different elements can be highlighted [Pruszynska, s.d.], [iThink Logistics, 2019]:

First of all, the system requires heavy and complicated maintenance to have the master data available in the system. Indeed, everything is changing fast and so, the system needs to be linked to the most recent data to be 100% efficient.

Moreover, if the system is linked to others like it is the case in an ERP, some errors can have big consequences. For example, having wrong information regarding inventory can lead to a big order that is not necessary, this will increase some inventory cost, etc. So, everything must be perfectly regulated to be optimal.

The implementation of Warehouse Management Systems is also exposed to failure, because of the complexity involved in the development and use of such systems. This means that the team in charge of building the system has to be an expert one. Based on that, the cost will be high and so, the system will not have a direct positive impact on the company's expenditures.

iv. Main providers

Again, to discuss some of the main providers concerning the Warehouse Management Systems, we can have a look at the Gartner magic quadrant dedicated to this topic. In the quadrant, it seems that most of the companies are either Niche players or Leaders, only three are mentioned as visionaries. In this quadrant, there are companies already discussed in previous section like SAP, Oracle, Infor.

FIGURE 31: MAGIC QUADRANT FOR WAREHOUSE MANAGEMENT SYSTEMS [GARTNER MAGIC QUADRANT 2020, S.D.]

1) Manhattan Associates

Manhattan's WMS is considered as a leader by the Gartner studies thanks to advanced Artificial Intelligence, machine learning technology and proprietary algorithms that are present in its solution. The tool is available whether on premises or on cloud which makes the solution flexible. Moreover, everything is concentrated on a single platform, which is interesting to find information and keep control. These elements create added value for a firm: the warehouse management is smarter, efficiency is improved, workforce and resources in general are maximized because everything is running smooth, which allows workers to be fully focused on their tasks, and inventory is well-managed. [Manhattan Associates, s.d.]

The company offers this service to different customers such as Under Armour, Martin Brower, Sysco, David's Bridal, etc. All these companies were able to support a quick and big growth thanks to this WMS. [Documents | Manhattan Associates, s.d.]

2) Blue Yonder

Blue Yonder is another leader according to results published by Gartner studies about WMS. Here also, the software allows companies to transform a warehouse into a digital environment where they can have a view on every action performed and have control. This is useful in a managerial and supply chain perspective. Blue Yonder creates a real-time access to inventory data, which means that every transaction is recorded and updates the inventory. Then, the storage is also optimized thanks to the tool: orders are placed when it is required, stocks are managed to avoid wastes, etc. Last, the tool offers managerial solutions for the warehouse to run it in the best possible way. Concretely, it implies a cost decrease up to 50%, the productivity increases up to 15% and an improved accuracy of 100%. [Blue Yonder, s.d.]

Blue Yonder helps its customers to fulfil their full potential thanks to the Warehouse Management System they provide. Amongst their customers, there are L.L.Bean, Albertsons, Infineon, Morrisons, Ahold Delhaize, Access, etc. [Customers | blue yonder, s.d.]

3) Körber

Körber is also a leader in the WMS field. This company offers a highly customizable system for warehouse management that fits with either small companies' needs or biggest companies' needs. The system can be used in both highly automated environments and small manual ones. In addition to that, it is possible to include this WMS into the existing ERP solution of a company.

Körber wants through its flexibility to fulfil all customers' expectations by reducing costs, improving supply chain management (orders, inventory, warehouse management), satisfy the companies' customers by providing transparent information and make easy to understand the growing complexity of this field. [Korber Supply Chain, s.d.]

Several customers have been impressed by the customization and flexibility demonstrated by Körber. There are AB InBev where the WMS helps to offer guarantee for deadlines, Asko where the distribution is now well-managed thanks to Körber, Araujo, Adore Beauty, Asko, etc. [*Références,* s.d.]

4) Reply

Reply is present among the visionaries in the Gartner graph. This product is dedicated to logistic projects that can easily be found in warehouse management. ClickReply Warehouse Management System insists on several points to describe its product. First of all, like other products discussed before, there is an emphasis on the flexibility. The tool is designed to manage and support different logistic processes and needs. Then, the scalability is the second important point. This means that the product is easy to duplicate, extend or migrate which allows customers to grow feeling supported by the tool. Third, this is a highly compatible tool that can be linked to others like an ERP in a company. Fourth, the solution is user-friendly and ensures that manipulations are easy to understand for Reply's customers. Last, data is updated in real-time and thanks to that, alerts can be launched automatically if an issue is faced by the system (inventory shortage, order issue, etc.). [Click Reply, s.d.]

Reply has customers in various field like Martini&Rossi, Barilla or Amadori for Food & Beverage, Franke, Condevo, Metalcastello for Manufacturing, Benetton Group, Calzedonia, BMW, Kenwood for Customers, and many others. [Click reply-Customer portfolio, s.d.]

5) Mantis

Mantis is classified as a Niche player by the Gartner magic quadrant graph. Despite this niche status, the software also provides quite the same services as the ones presented before. Mantis offers

a Warehouse Management System that takes care of warehouse in different aspects: vision, value, automation, and control. Moreover, it is useful for its customers to make some logistics and supply chain management. Through its adaptability, Mantis tries to adapt to customers' needs and appears flexible, with the objective to maximize performances of the warehouse. Moreover, there is an e-commerce management opportunity proposed by Mantis. [Mantis, s.d.]

Mantis receives several awards for its software: Supply Chain Awards 2020, Supply Chain Provider of the Year 2020, etc. Amongst its customers, we can cite Coca-Cola, Samsung, GSK, Tefal, Reebok and Vodafone. [Mantis, s.d.]

6) Vinculum

Vinculum is another company located in the Niche player part of the Gartner graph. The basic idea of this company is "Sell anywhere, faster". The activities proposed by Vinculum are relatively similar to those mentioned above: inventory management, e-commerce management, etc. This is possible because of the wish to reduce risks caused by the increased complexity of the market, the automation of processes and the tracking of orders available in real-time. [Vinculum Group, s.d.]

The customers that are relying on Vinculum are the following: DTDC, Riverwood, LBC, Lion parcel, fm Global Logistics, etc. [Vinculum Group, s.d.]

f. Operations Support Systems (OSS)

i. Definition

On a broad perspective, OSS are useful for companies to manage their networks. The overall objective is thus to improve the efficiency of a firm on an operational point of view. Indeed, this system allows them to perform different actions. First, it is used to manage network inventory. Second, it is used to manage the network configuration within a company. Third, this is used to deal with fault management in a company. To summarise, an OSS software is useful for network monitoring, control, analysis and management. [Reynovitch, 2016]

Operations Support Systems can be separated into three distinct types of Information Systems. There is first the Transaction Processing Systems which are systems dealing with recording and processing of transactions in companies. Transactions are economic events that happen in the companies (sales, orders, inventory, etc.). Then, there are the Management Information Systems that try to provide useful information to managers with an analysis perspective. This means that the system will try to give the best past and current information so that the manager can take the best possible decision for the company's future. Third, OSS can be part of an Enterprise Resource Planning which is a system that has already been discussed a lot. [Samiksha, 2013]

With the current evolutions, OSS are dealing with topics that are very present in the news and actual discussions concerning technologies. Indeed, the new way of thinking in OSS will have to deal with topics such as 5G, IoT, Industry 4.0, Artificial Intelligence, etc. Because of these new technologies, the OSS field will face a major evolution now and in the near future, and companies will have to constantly adapt their offerings to cover the market needs. [Amdocs, s.d.],

ii. Advantages

There are several advantages linked to OSS [Nawab, 2015]:

First of all, the management of the networks in a company allows it to improve collaborations of its members. It is also a way to support and enhance communication inside teams and between different teams.

Moreover, processes are better managed thanks to the network management improvement. Consequently, information goes quicker from one place to another, and so processes are optimized, controlled and well-defined. This also provides a time and money saving opportunity.

Last, the company is able to define, control, manage and improve its data collection thanks to a harmonized network between its different activities. Thanks to stronger data, the created information will be easier to use and understand, and will provide opportunities: unique value proposition, competitive differences, etc.

iii. Disadvantages

On the other side, there are some drawbacks that must be mentioned. As OSS can be part an ERP tool, the ERP disadvantages can be linked to this part too (See ERP part). Moreover, there are other elements [Samiksha, 2013], [Nawab, 2015]:

First, this is very important for companies to have a strong security behind these systems. In case of hacks, a lot of data is exposed and can cause harm to companies. Indeed, the system has to deal big amount of data and the data is often of high importance and can even be vital for the company.

In addition to that, the system must be performant because it deals with a lot of data that comes quickly. So, if the system is too slow and cannot manage all the operations, this will not be optimal for processes and data management.

iv. Main providers

In this section, different providers will be presented. There are market leaders, challengers, visionaries, and niche players, according to Gartner magic quadrant for Operations Support Systems. Most of the time, the platforms provide both OSS and BSS solutions (see Section 7. Types of Information Systems).

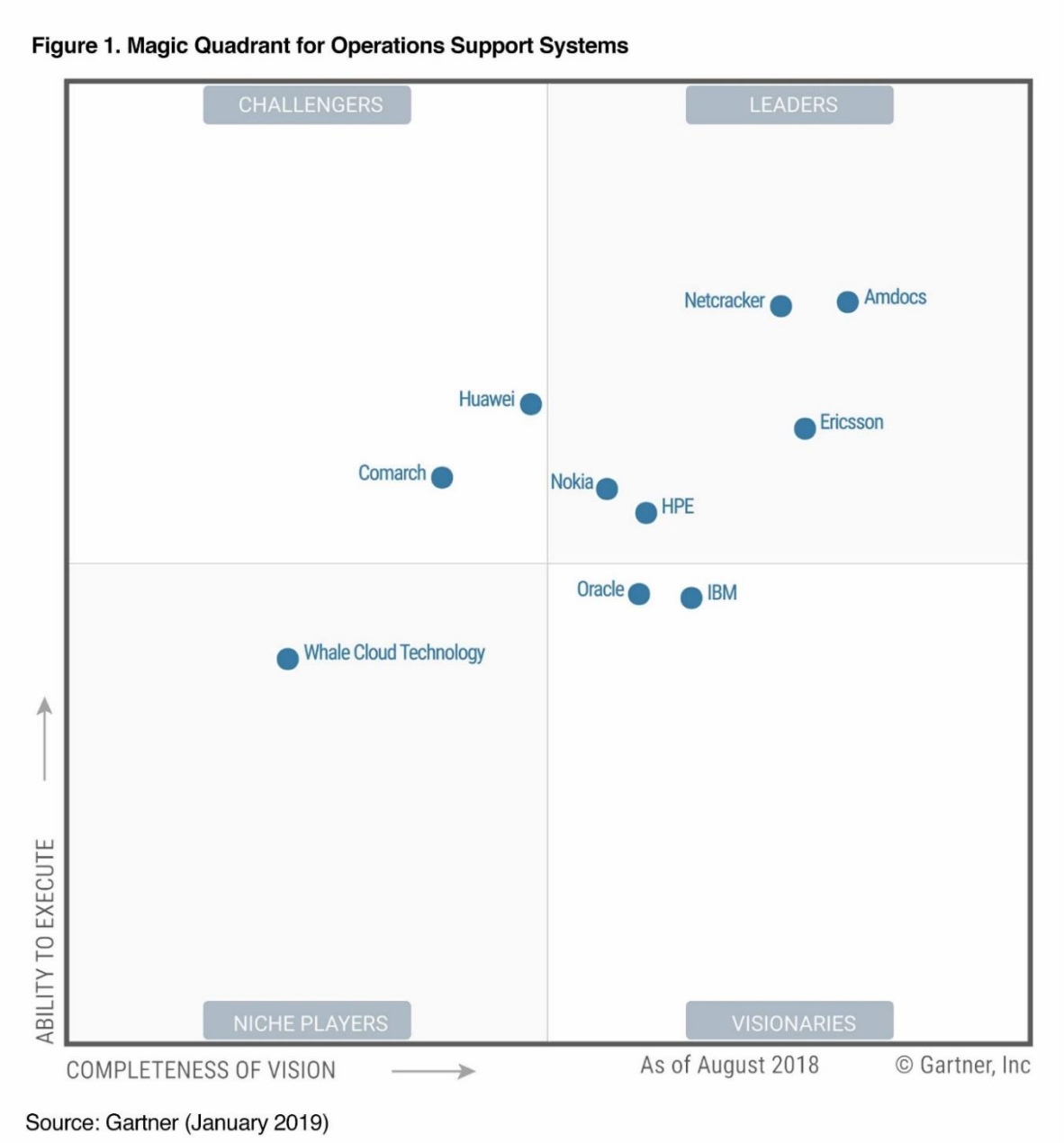


FIGURE 32: MAGIC QUADRANT FOR OPERATIONS SUPPORT SYSTEMS [JEFFREY, 2019]

1) Amdocs

Amdocs is considered according to Gartner's studies as the best provider of OSS. In addition to that, the brand is also recognised by Frost & Sullivan's new product innovation award as the global next generation OSS. The brand provides a tool that strongly relies on cloud technology. The company provides a tool called Amdocs NEO which is described as:" An innovative and advanced service and network automation platform". The platform provides opportunities in term of lifecycle management that is composed of different modules, agile and open. [Amdocs, s.d.]

Among the companies that make the Amdocs choice, there is SES, a global operator leader. [Amdocs, s.d.]

2) Ericsson

The Ericsson OS system is based on the new way of thinking in companies and tries to support this as much as possible. Therefore, the tool supports horizontal management by providing open and model-driven platform. This is the new way of designing OSS. As for the Amdocs tool, the idea is to provide a transformation opportunity to companies thanks to its platform. [Ericsson, s.d.]

There are several customers trusting Ericsson: Celcom, Batelco, Avea, Airtel, Digicel, etc. [Featuredcustomers, s.d.]

3) Comarch

Conmarch is among the challengers in the OSS field. The company provides Operations Support System that has the objective to optimize telecommunication business processes. Conmarch provides a customizable OS system which can be adapted by companies following their technological evolutions. So, this is a hybrid network that follows business evolutions. As an example, Conmarch has already studied and is getting prepared for 5G era. That shows the adaptability of the tool, that can now be developed with 4G perspective and further adapted to 5G elements. [Conmarch, s.d.]

The Conmarch's customers are mainly telecommunications companies: T-Mobile, Telefonica, Vodafone, Orange, ngena, Telenet, etc. [*Conmarch-Global it business products provider,* s.d.]

4) IBM

As a visionary on the magic quadrant, IBM OSS is designed to meet the needs of Communication Service Providers. Thanks to the platform, companies are able to perform analysis of their operations, the OSS provided can be adapted and is based on real-time information, with a guaranteed security. IBM OSS helps its customers to deal with the complex current situation with a mix of on-premises, hybrid, and cloud solutions. [*Use analytics to find problems and avoid outages*, s.d.]

Among its customers, there are: Ultra Petroleum, Globo, DP World Australia, North Pacific Bank, etc. [*Ibm oss reviews, competitors and pricing,* s.d.]

5) Whale Cloud Technology

Whale Cloud Technology is the only niche player in the magic quadrant. The brand provides OSS that makes different actions [Whale Cloud Technology, s.d.]: Provisioning Center, Unified Home Broadband Support which increases management, quality, user experience and performances, Comprehensive Resource Management System which optimizes the resources management (spatial, physical, logical, etc.) and iNOC where NOC stands for Network Operations Center.

The company offers services for True, the largest operator in Thailand and for KPN, a big telecom and IT service provider in the Netherlands. [Whale cloud technology co., s.d.]

g. Data Quality Solutions

i. What is data quality?

Data Quality is, as its name implies, a measure of the overall utility of data regarding several criteria such as accuracy, completeness, consistency, timeliness, validity, and uniqueness. So, the idea is to identify if the data is ready to be used for analysis in different situations like databases, data warehouses, etc. Data quality is part of the data governance and management process of a company in a way that it will guarantee that data within the company is ready to be used and corresponds to reality. [Wikipedia contributors, 2021], [*What is data quality-Informatica*, s.d.]

On a general point of view, it is possible to define data quality regarding this virtuous cycle that clearly explains the different steps considered in the data quality process. These elements can be divided in four different phases that help to improve data quality [*What is data quality and why is it important?*, s.d.]:

1) Discover your data: what you have, what are the relationships, how is it registered, etc.
2) Define how to reach the desired state: draw rules that need to be followed to improve data quality.
3) Apply the rules to the data.
4) Analyse the outcomes and the effects, see if the rules were coherent and help to reach the desired data quality.

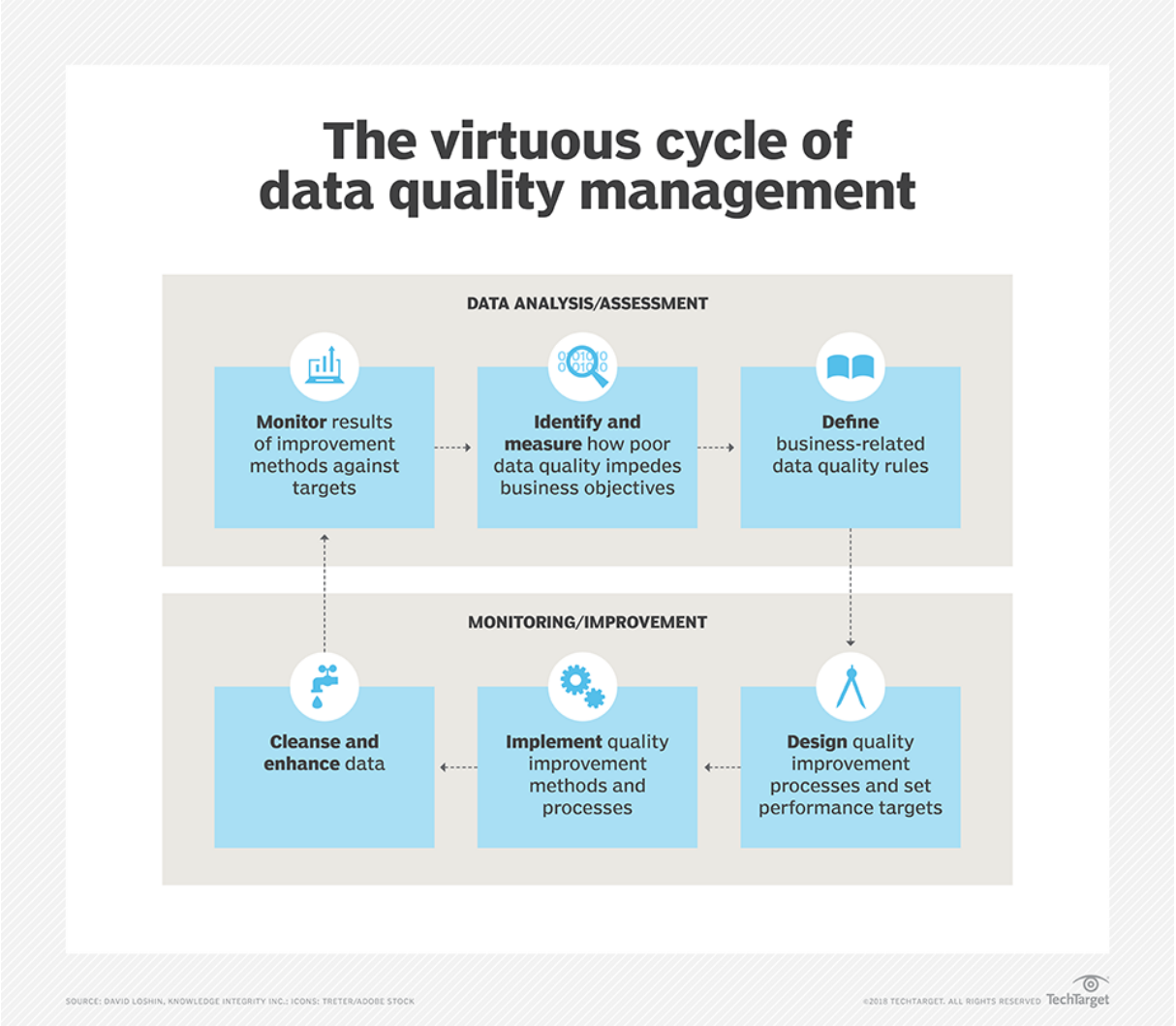


FIGURE 33: [WHAT IS DATA QUALITY AND WHY IS IT IMPORTANT?, S.D.]

ii. Why is it useful for companies?

By having a good data quality inside a company, some issues are avoided. One example is the delivery of goods in the wrong location because of a wrong data. In this situation, the consequences can be bad for companies with extra cost, delays in delivery, bad customer satisfaction, etc. So, data presenting issues must be directly identified to optimize the process.

Thanks to a good data quality, companies are able to take the best decisions possible. Indeed, having the best data possible allows to create the best information possible. Thus, it becomes possible to develop Cloud analytics, Artificial Intelligence or Business Intelligence because they are now able to rely on the data available. That is one of the factors explaining why some are reluctant to adopt Business Intelligence and Analytics models.

With better decisions and better insights on data, companies are also able to improve the productivity and efficiency. This means that investing in data quality will lead to better revenues in different levels of the companies. Moreover, once the data reaches the desired level of quality, the process just needs to be maintained and the cost are less important. [*What is data quality-Informatica*, s.d.], [*What is data quality and why is it important?*, s.d.]

iii. What are the risks and drawbacks of poor data quality?

In a nutshell, we can define data as a basis of a pyramid to understand its importance in an enterprise. Without a good data quality, it is difficult to build something solid and coherent in a company. [*Data quality-What, why, how, 10 best practices & more.*, s.d.], [*What is data quality-Informatica*, s.d.]

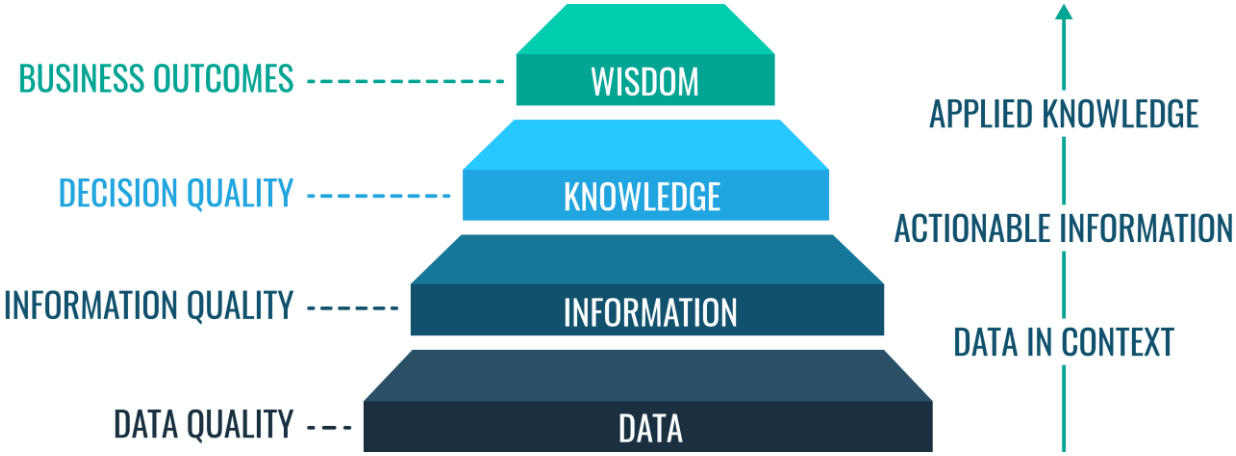


FIGURE 34: WHY IS DATA USEFUL? HIERARCHY MODEL [DATA QUALITY-WHAT, WHY, HOW, 10 BEST PRACTICES & MORE., S.D.]

Having a poor data quality in companies creates several issues. First, this leads to a biased analysis of the current market situation, regardless the field. This bad interpretation often relies on a wrong offering, a poor understanding of the customers and a biased market segmentation.

Then, poor quality in term of data obliges employees to perform time-and-effort consuming activities to obtain what they want. Because of that, the company loses opportunities to quicker expand its business.

Last, not having an optimal data quality in a company also creates ambiguity and complexity around processes. Indeed, if the data is not accurate, it is difficult for its member to understand clearly how it works, what actions need to be performed, etc.

iv. Main providers

According to the magic quadrant, we can see that there are numbers of solutions available to improve data quality in a company.

Figure 1. Magic Quadrant for Data Quality Solutions

Source: Gartner (July 2020)

FIGURE 35: MAGIC QUADRANT FOR DATA QUALITY SOLUTIONS [INFORMATICA, S.D.]

1) Informatica

Informatica is a data quality solution that provides different solutions to be a leader in the Data Quality solutions software. First, Informatica offers flexibility to its customers so that they are able to deploy a solution according to all type of use cases. To ensure flexibility, the user experience is designed to satisfy all profiles regardless the skills, experience, etc. Then, it is possible with this software to deploy your solution on different environments like Big Data, web services, etc. Last, thanks to CLAIRE engine, the software offers personalized recommendations, advice, … to use the tool in an optimal way and to increase both productivity and efficiency. [*Data quality tool and software*, s.d.]

There are several customers that are convinced by the solution. Among them, there are AGL Resources, ACE Hardware, Adventist, Axa, Chicago Cubs, Colruyt, Daewoo, etc. [Customers – customer success, s.d.]

2) Talend

Talend Data Fabric is a platform that allows to perform different actions on data positioned as a leader in Data Quality Solutions. Indeed, it is not only a Data Quality Solution. Talend is also dealing with data integration. One part of this platform is busy with data integrity and governance. That is the part interesting in the data quality section. This part allows companies to follow and analyse their data throughout all their journey in the company. This is possible thanks to the Talend Trust Score that helps to identify the relevance and reliability of the data in the current process and also helps to identify potential issues. [Talend, s.d.]

Thanks to its tool that combines both Data Quality and Data Integration solutions, Talend has customers like Toyota, L'Oréal, Bayer, Domino's and Citi. [Talend, s.d.]

3) Experian

Experian is another provider of Data Quality Solutions and is considered according to the Gartner magic quadrant as a Challenger in the field. The software is based on three pillars. First, there is a Data Validation Service that is useful to clean, tidy up and validate your data. Second, there is a Data Quality Management part in the software that is used to perform maintenance and regulation in different contexts like a data migration. Third, there is a Data insights part where you can have a view on your data and do something with it. Indeed, collecting and having good data is good but it is better to take actions thanks to data you can trust. [*Untitled,* s.d.].

The customers that believe in Experian solution are Aldo, Overstock, Cabelais, Northwestern University, Midmark, etc. [*Untitled,* s.d.].

4) Atlaccama

Atlaccama is a visionary in the magic quadrant and provides a solution for data quality: self-driving data quality management. The tool allows to perform the actions described previously like understanding the current situation of your data, validating it, improving the situation, etc. Moreover, the tool will send alerts when wrong data enter in the system based on a continuous monitoring through Artificial Intelligence implementation. [Ataccama, s.d.]

The customers of Atlaccama are varied: Avast, T-Mobile, TIAA, Origin, Darden, etc. [Ataccama – Customers, s.d.]

5) Syniti

Syniti is considered as a Niche player in the Data Quality Solution market. The firm insists on the fact that they want to find as quick as possible potential issues in data to avoid misleading processes and poor decisions. The basic idea is thus to identify and predict all potential issues in the data available in a company to improve the efficiency of the business, increase the confidence in the company's data and anticipate future trends. [Sinity data quality, s.d.]

Different companies coming from different field trust the Syniti Data Quality Solution. There are Geberit for pharmaceuticals, Maple Leaf Foods for food and beverage, McDougall Energy, Buro de Credito, etc. [Customer success stories, s.d.]

h. Data Integration Tools

i. What is data integration?

After having performed some data quality management, companies are able to integrate data using some Data Integration Tools. Indeed, if a firm does not have a good data quality, it appears difficult to start an efficient integration process. To be concrete, data integration is: "the process of

combining data from multiple source systems to create unified sets of information". The objective behind data integration is to create value by providing useful information. [Stedman, s.d.] [*What is data integration*, s.d.]

Among the most famous data integration tools, we have the one which is called ETL. This tool is working in three steps: Extract, Transform and Load. The first step (Extract) consists in retrieving the data from different data sources that can be varied. Then, the second step (Transform) consists in modifying the data (types, relationships, etc.) to have a homogeneous data set and have data that is compatible. Third, you have the Load step where all this transformed data is loaded in a new location where you do not have different sources anymore but rather a single one. [*What is extract, transform, load?*, s.d.]

ii. Why is it used?

Data integration is useful for different points that will be discussed in this section.

First of all, integrate data can solve issues regarding Big Data. Indeed, thanks to Data Integration Tools, it is possible to give sense and power to the high amount of data stored. Then, the integration will solve the issue related to silos that are still present in companies. By providing a unified set of data, the silos will disappear, or it will at least create pipelines between them. This can also be linked to some accessibility issues that will no longer represent a problem thanks to unified information set created by the integration. Another important point is that data integration will create a common syntax regardless the data sources. By that, it means that dates will be registered according to the same format, etc. [*What is data integration*, s.d.]

Moreover, data integration will bring added value to companies using such tools. The benefits are varied: gain in time by accessing the data in an easier way, gain in money because the productivity is improved, gain in time and effort because the processes are optimized, etc. This is possible because data integration allows to develop Business Intelligence, Decision-making processes, Master data management, Customer Relationship Management, … [*What is data integration*, s.d.]

iii. What are the challenges?

Implementing a good data integration process in a company represents also several challenges to have an optimal process. [Gupta, 2018]

First, the company needs to have a good understanding of the current situation in terms of data sources, data relationships, … and a good view of the objectives to achieve with data integration. Indeed, if the logic behind the current situation is not understood, it will be difficult to create a homogeneous set of information after the process.

Second, given the amount of data that will be integrated, it is essential to count on good system performance otherwise it will be more a waste than a gain in time. The performance will be good if the relationship and the structure are well designed.

Last, the integrated set needs to be easy to access, useful for all the company's members and understandable regardless the function of the members.

iv. Main providers

Because of the close link between data quality and data integration, it appears that some of the main providers of data quality solutions are also the main providers of data integration tools. This is the case of Informatica, IBM, SAP, Talend, etc. More precisely, it is mainly the case for the leaders in

the markets (both quality and integration leaders). For other segments as Niche players, the tools seem to be more precise and so, less concerned with data quality.

Figure 1. Magic Quadrant for Data Integration Tools

Source: Gartner (August 2020)

FIGURE 36: MAGIC QUADRANT FOR DATA INTEGRATION TOOLS [DATA INTEGRATION TOOLS, S.D.]

1) Informatica

As well as for the Data Quality Solutions, Informatica appears as a strong leader in the market of Data Integration Tools.

The objectives are the following for Informatica [*Data Integration | Informatica*, s.d.]:

- Provide a simple integration and ingestion of the data.
- Create high productivity in a company without having a tool that requires complex coding.
- Provide data integration of high performance, with a high scalability and an automated process.

Concerning the customers, they are the same as for the Data Quality part. Indeed, what is interesting with Informatica is also the opportunity to complete the full process with the same company. [*Data Integration | Informatica*, s.d.]

2) Talend

Talend is in the same situation as Informatica with a lead in both Quality and Integration solutions. Talend offers a Data Integration tool called Talend Data Integration. With this tool, it is possible to perform many actions like connecting with different data sources to manage them, developing and deploying solutions to connect these different sources based on drag-and-drop which is much easier to understand than coding, … Moreover, Talend offers opportunities to integrate your data with the best Cloud Database Management systems that were presented before such as Amazon Web Services, Google Cloud, Databricks and Microsoft Azure. These partnerships are interesting and show the possible links between different systems. [*Data integration solutions*, s.d.]

3) Qlik (Attunity)

Qlik as already been discussed in previous section about Analytics and Business Intelligence tool. It seems logical to deal with Business Intelligence and Data Integration as BI can be seen as the next step after a good data integration.

As a challenger on the market, Qlik offers a Data Integration platform which has as main objective: "*to deliver analytics-ready data to the cloud in real-time with modern DataOps for analytics from Qlik (Attunity)*". Qlik Data Integration Tool performs action as an ETL tool: it extracts data from multiple sources, transforms the data to make everything compatible and load it in a single database which can be a data warehouse, a data lake, or a database. [*Qlik data integration*, s.d.]

Some customers success stories of Qlik are Airbus, Ford, PayPal, Deloitte, NHS or Lloyds. [*Customer success stories*, s.d.]

4) Information Builders

Information Builders (ibi) is a firm that is present in both quality and integration field in a role of visionary according to Gartner studies. The firm wants to provide an easy solution to deliver a complete data transformation to companies. At first, they offer a data preparation (Data Quality Solutions). Then, they are able to extract data from various sources (cloud, big data, batch, …) and regroup all the information on an easy-to-use platform where changes in data are quickly visible. The company insists on its flexibility, adaptability and scalability which means that the solution provided can be easily adapted regarding the field, the size, the amount of data, etc. [*Data platform for integration, data quality, and governance*, s.d.], [*Why ibi*, s.d.]

The firm has convinced several customers among General Motors, Royal Bank of Canada, StLukes University Health Network, Coty, FedEx, etc. [*Why ibi*, s.d.]

5) Adeptia

Adeptia is considered as a Niche player in the Gartner magic quadrant. This company is only dealing with data integration rather than combining both data quality and integration. This company provides an ETL tool that allows Data Integration [*Etl data integration & transformation software | adeptia*, s.d.]. ETL has already been discussed in the section "What is Data Integration?". The firm can count on some customers in different fields. The case study concerning Data Integration mentions among them an important commercial bank in the United States. [*Case study on financial data integration | Adeptia*, s.d.]

i. Manufacturing Execution systems (MES)

i. Definition

A Manufacturing Execution System (MES) is an Information System that deals with the factory side of a company. Its objective is to manage complex manufacturing systems but also data flows that are used in these systems. Therefore, a MES wants to improve the operations and increase the productivity.

When looking more in details, a Manufacturing Execution System mainly deals with data. Indeed, the software retrieves real-time data during the whole production process. It goes from the first order until the final delivery and can concern performance, traceability, material management, etc. Thus, it ensures a follow-up to avoid losing information and getting lost. This is very useful in cases where the orders and production processes are varied and big for a company.

This tool is very interesting to use for many companies because it allows to create links between different systems. According to ISA-95, MES is the perfect intermediate between an Enterprise Resource Planning (ERP) and the process control systems that are used on the factory floor. Therefore, that is why such a system is often included in an ERP tool. [Kakade, s.d.], [Manufacturing execution systems (Mes), s.d.]

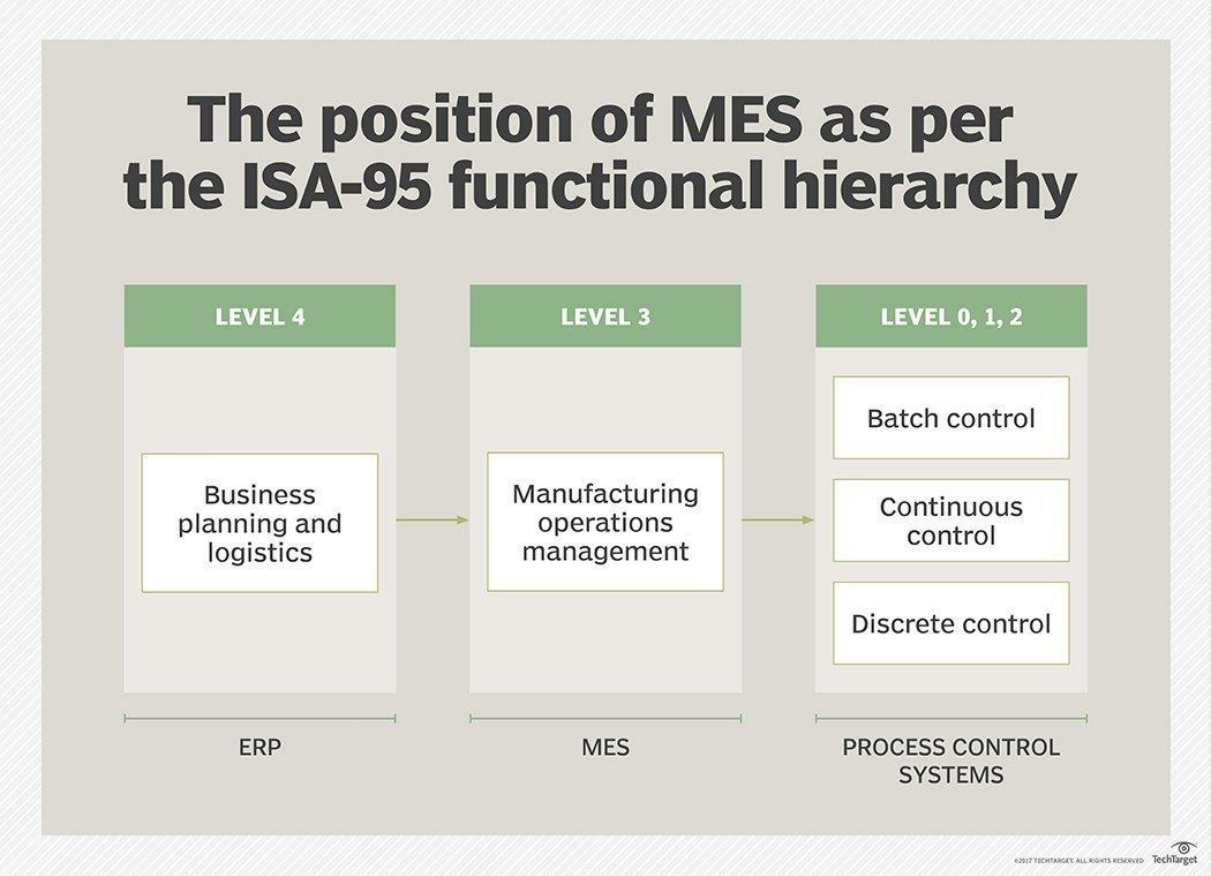


FIGURE 37: HIERARCHY OF MES [KAKADE, S.D.]

ii. Advantages

Manufacturing Execution systems are built to provide some advantages [Kakade, s.d.], [*Manufacturing execution system: Pros and cons,* 2020]:

First, the system is very useful for companies to optimize their manufacturing processes. Here are examples of optimization: better visibility of the supply chain, shortened manufacturing cycle, automated process and recording of activities, shorter delivery times, optimized use of machines, …

Second, these elements allow also to highlight a less costly process for companies because everything is better managed and organised concerning the manufacturing processes. An example is the decrease of the inventory costs thanks to the better targeting and adaptation of the production to the current customers' needs.

Third, the two big advantages mentioned before lead to a third one: customers are more satisfied than before thanks to these improved processes and the better management. This is thus a win-win situation for both the company and its customers.

iii. Disadvantages

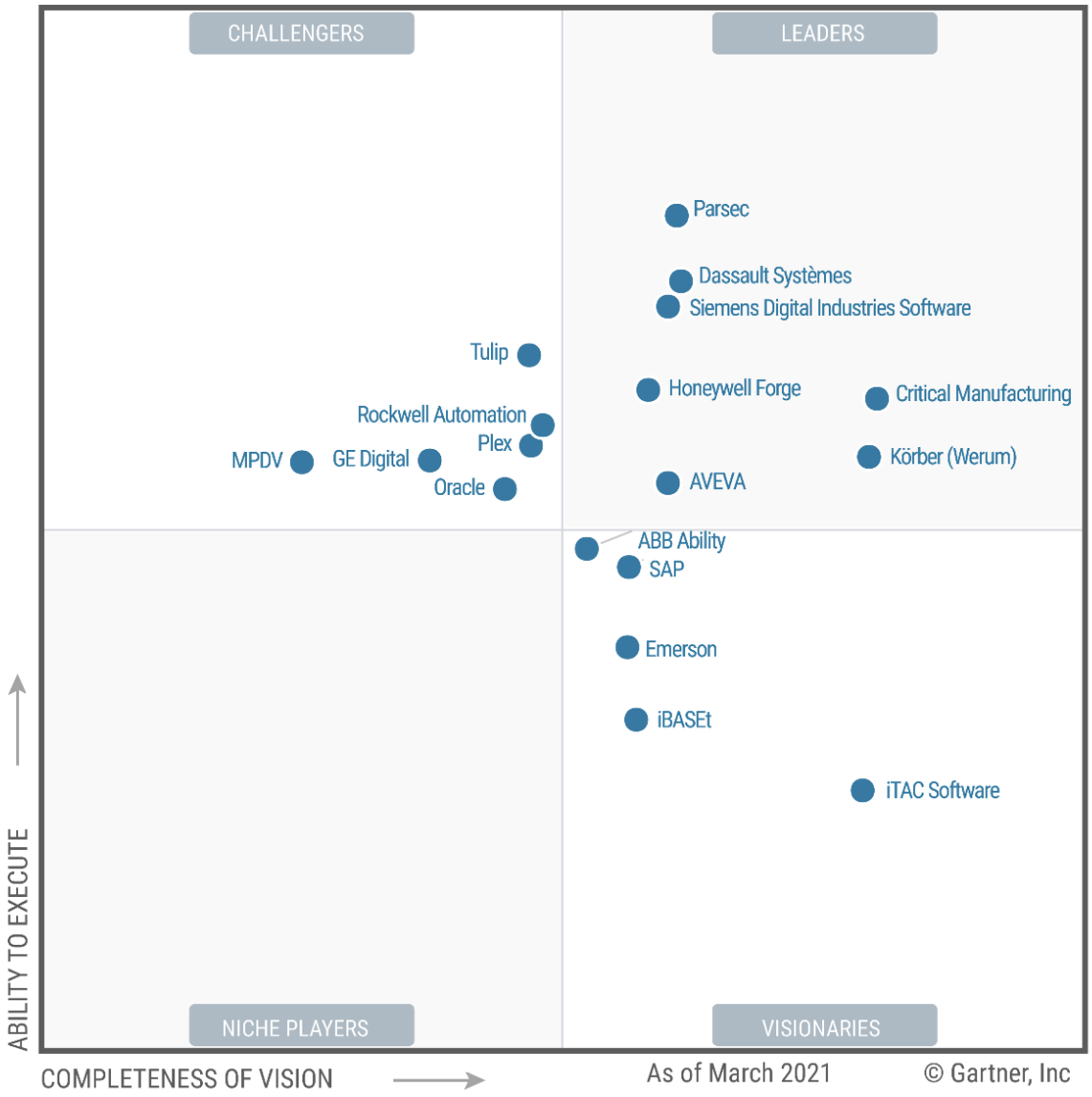
As for every system previously discussed, the costs of implementing an Information System in a company remains a barrier for some. THere is a financial risk of developing a MES, and that is why it is mentioned as a disadvantage. Indeed, it is first difficult to exactly forecast the cost of the implementation. Then, it also appears as an investment for companies, and it may require a significant budget. Moreover, the project is not a guaranteed success because it relies on some uncertainties which can cause failure: the project does not meet the expected deadlines, , the project expenditures are above budget, the project does not provide the desired effect nor meets the expectations, etc. [*Manufacturing execution system: Pros and cons,* 2020].

iv. Main providers

As shown in the magic quadrant above, there are numbers of Manufacturing Execution Systems on the market. It appears that the providers are not focused on some niche markets. They are separated into three categories: leaders, challengers, and visionaries. Here again, we can see that some providers are not only dealing with MES but are also present in other fields that were discussed (SAP, Oracle, Körber, etc.).

Therefore, we will discuss some of the 18 providers from the three different graph locations: leader, challenger, and visionary.

Figure 1: Magic Quadrant for Manufacturing Execution Systems



Source: Gartner (March 2021)

FIGURE 38: MAGIC QUADRANT FOR MANUFACTURING EXECUTION SYSTEMS [SIEMENS, S.D.]

1) Parsec

Parsec is a company that commercialises a MES called TrackSys. The tool allows to perform different actions for a company.

First, it is possible for a company that uses TrackSys to optimize the manufacturing processes that are in place.

Second, thanks to the real-time data management, it is possible to have insights and understand what can be improved in processes. This allows to make directly efficient changes by taking real-time decisions. The change is thus everywhere, at every time.

Moreover, this MES is offering the opportunity to see all the workflows in place in the company which is very useful. Thanks to TrackSys, you can easily visualize them and understand all the interactions in the processes.

Parsec counts several customers that are using its MES to optimize, control, understand and have a better view on their manufacturing processes. Among them, there are: Nestlé, DHL, Heineken, Bridgestone, Bimbo, Coca-Cola, etc. The industries are thus diversified. [Parsec automation corp., s.d.]

2) Siemens Digital Industries Software

Amongst the market leader for Manufacturing Execution Systems, there is Siemens Digital Industries Software. The brand provides a system that is highly customizable to fit with all customers' needs. The overall objective remains the same as for other MES: control and view on the manufacturing processes.

The control and view on the manufacturing process rely on several characteristics: data collection and acquisition that are useful to better understand the processes and get information for further decisions. Moreover, the company keeps all its information and documents under control. This is also useful to analyse and understand the performances. Then, there is the dispatching production that allows companies to optimize their processes, gain time and money, etc. Also, the companies can easily manage the workforce about manufacturing still with the aim of optimizing. Last, there is also a part that is dedicated to maintenance, storage, and evolution. So, the system deals with the current situation but also tries to find room for improvement. [Siemens Digital Industries Software, s.d.]

The firm's customers are varied: Liebherr-Components Biberach, Viega, ICCO EMT, Gruppo Campari, etc. [*Recherche d'étude de cas*, s.d.]

3) AVEVA

Another leader discussed is the AVEVA Manufacturing Execution System. The tool is described by AVEVA as a way to*:" Maximize profitability, quality, and compliance of manufacturing operations*". This is clearly the objective of MES. More broadly, AVEVA provides companies opportunities to switch to digital. Therefore, one of the features proposed by the MES is to digitalize Manufacturing Execution Systems. [*Mes manufacturing execution system for batch and hybrid processes*, s.d.]

Amongst their customers, there are: Italpresse Gauss, Schneider Electric, Valmet Automotive, Abu Dhabi National Oil Company, Nita Labelling Equipment, etc. [*Aveva software success stories,* s.d.]

4) Rockwell Automation

Rockwell Automation is among the challengers in the MES field with its tool called Factory Talk Production Centre. As all others Manufacturing Execution Systems, the goals of such system are to increase productivity and efficiency and save time and money. The tool is convenient for different types of industries: single-plant, multiplant or even industry-specific needs. It integrates quality management and business analytics (these are two points already discussed) to provide the best opportunities to companies. Indeed, by having the best data quality possible, and a detailed and useful analysis of its data, a company is able to manage its manufacturing in the best possible way. [Rockwell Automation, s.d.]

Rockwell Automation counts several customers. There are among them Synthomer, MP Equipment, Seattle-Tacoma International Airport (SEA), Marlen, etc. [*Case sturies | customer success stories*, s.d.]

5) Emerson

Emerson is also providing a Manufacturing Execution System and is located, in the Visionary section of the graph according to Gartner's studies. The three pillars are the simplification of the process, the optimisation of data management and the information integration. Based on these points, it appears that Emerson is not only focused on Manufacturing Execution Systems even if this is an important part for the company. Indeed, this system helps the company to reach its global goals which explains the development of a MES.

Concerning the MES which is part of the company, the objectives are quite the same as other providers. With its tool called Syncade, the emphasis is placed on the manufacturing optimization that helps to reach productivity and execution goals. To do so, the firm provides tools to manage documents and orders, to manage equipments and materials and finally to integrate information. [Emerson BE, s.d.]

The customers are diversified: Repligen, a pharmaceutical company, has improved its productivity thanks to Syncade; Handok Incorporated has decreased paper consumption thanks to automated processes and digital transformation; UCB has standardized processes and has developed and automated reporting and process management thanks to Syncade, etc. [Emerson BE, s.d.]

j. Sales Performance Management (SPM)

i. What is Sales Performance Management?

Basically, sales performance is the measure of the effectiveness of the sales team. This describes the sales activities, the level of goals achievement, some KPI's like the revenues generated or the time spent per customer. [Sherman, 2019]

Sales Performance Management (SPM) is the set of sales processes that aim to improve the effectiveness, efficiency, and sales performance in general of the company. According to Gartner, SPM is:" A suite of operational and analytical functions that automate and unite back-office operational sales processes. SPM is implemented to improve operational efficiency and effectiveness." [Inc G., s.d.]

A SPM is dealing with different elements that are close to "sales". Indeed, when mentioning SPM, there are sales incentive compensation management (the fact to promote and try to increase the sales), objectives management (have clear KPI's and goals defined), quota setting and planning management (plan the number of sales, the prices, etc), territory optimization, advanced analytics, gamification, etc. [Sherman, 2019] , [OpenSymmetry, s.d.]

ii. Why is it useful?

Sales Performance Management is useful for different aspects that can be highlighted thanks to the elements that were discussed in the previous section. [Sherman, 2019], [OpenSymmetry, s.d.], [Patricia, 2019]:

- Increase the sales: by setting clear objectives and defining incentives, companies will be motivated to increase their sales.
- Moreover, with the SPM, you will have a clear view on what is good and what is not good. So, the right decisions can be taken with transparency and honesty in a company.
- Another positive aspect is that such a system can prevent a company from failures. With forecast, goals setting and planning, the company will be well structured.

- On a human perspective, the system will allow every employee of the society to feel involved in the process. Indeed, everyone will have a clear objective that he will be willing to reach. The company will become result-oriented which can create and enhance motivation.
- The SPM will allow to highlight the elements that are under-performing throughout the process (employees, processes, etc) and will allow to correct these elements to increase the performance.

iii. What are the drawbacks?

On the other side, companies must be careful when they introduce Sales Performance Management systems because it can be difficult to implement and to be understood by every member of the firm. It can consequently lead to some issues [Patricia, 2019]:

- Discouragement: if the results do not meet expectations, some members can be disappointed and loose motivation. Moreover, if the message shared by the company is not easy to identify and if the performances are not aligned with it, employees can lose motivation too.
- The processes can easily be biased to increase the measures. Doing that, everything will be distorted, and the system will not be useful and efficient.
- As for many others, implementing a Sales Performance Management system in a company is time-and-money consuming.

iv. Main providers

Again, it exists number of providers to manage the sales performance in the market. These are presented in the latest Gartner magic quadrant. Some of the companies present on the graph will be further discussed. As already mentioned, some of them were already presented in other sections since they do not only commercialise SPM.

FIGURE 39: MAGIC QUADRANT FOR SALES PERFORMANCE MANAGEMENT SYSTEMS [XACTLY GARTNER, S.D.]

1) Varicent

Varicent is one of the leaders on the Sales Performance Management System market. It is a tool developed by IBM. The tool covers all the criteria discussed in the definition section of SPM. So, it allows a company to improve its sales performance and growth. There are different companies that use Varicent: T-Mobile, Shopify, Siemens Healthineers, ThermoFisher, etc. [Varicent, s.d.]

2) Xactly

Xactly is another leader in this field. The main objective of a company that uses this platform should be to start a revolution about its revenues. Indeed, the idea of Xactly is to highlight the pain points of companies by analysing their data and finding a way to increase revenue and performance. [Xactly, s.d.]

Xactly has the following customers: CoxAutomotive, Coupa, Databricks which means that some Information System uses other Information Systems to be efficient, Flowserve, DocuSign, etc. [*Customer story overview*, s.d.]

3) Optymyze

Optymyze is also amongst the leaders on the market. To be concrete, the brand provides quite the same services as the two previously discussed. So, the aim is to improve performance by doing several things like planning, setting quotas, defining incentives, etc. The point on which Optymyze insists the most is the fact that the platform is on a no-code basis. [Optymyze, s.d.]

Among its customers, Optymyze has McKesson, Sunovion, PC Connection, KForce, Echo, etc. [Featuredcustomers, s.d.]

4) NICE

Nice appears to be a challenger in the Sales performance market. The overall objective of this company is to provide the "Perfect customer experience". Through this general topic, the Sales Performance Management is an important point. To do so, they offer different opportunities with their tool like reducing operational costs, increasing the agility of the solutions, increasing transparency, etc. [NICE Systems, s.d.]

Several companies trust in the NICE Sales Performance Management platform: Sunrise upc, Continuum Global Solutions, Ritter Communications among other. [*Customer success | nice*, s.d.]

5) Incentives Solutions

Joopy Incentive Solutions is the only SPM software considered as visionary. The company builds a solution that fulfils different needs. First, it allows its users to make their business grow. Second, it simplifies the sales processes. This is interesting for companies because they will gain efficiency. Third, the tool increases the employees trust and confidence because their performances are analysed by the tool and they are more motivated to better performed. Last, the tool provides control on revenues, budget, plan, etc. [Incentives Solutions, s.d.]

The Joopy's customers are the following: Visa, Zim, Renault, Nissan, Nestle, AIG, Swisscom, etc. [Our clients incentives solutions, s.d.]

6) Performio

Performio is the only Niche player represented in the Gartner graph. This means that, according to the Gartner's studies, the tool is less complete in term of vision and has less execution ability. The brand presents its tool as an opportunity to gain time and to use it to plan new market entrance, products development, change in the companies, etc. So, the focus is placed on the performance of the company. The idea is to perform more actions in less time but keep the same efficiency. [Performio, s.d.]

Performio has among its customers the following companies: Astra Zeneca, Simplifi, Vodafone, Optus; Browser Stack, etc. [Performio, s.d.]

10. Relations between different systems

It seems clear that companies do not use only a single Information System. Indeed, companies use different systems depending on the sectors, departments, needs, …. For example, there are systems dedicated to manufacturing, others that deal with communication, etc. To make those systems efficient, companies have to make them interact and to create relationships between them. By creating these interactions, the use of information systems makes sense. It allows the information to go from one part of the organisation to another and it gives the organisation's different departments the opportunity to perform as a whole.

Nevertheless, it is very costly and time-consuming for companies. That is why they invest a lot in IS development and maintenance. Indeed, every new application has to make the information flow to the system. So, the different systems and applications used must be compatible, and, everything has to be integrated into the global organisation information system. [*Management information systems,* s.d.]

In the below visual, there is an example of interactions between different information systems that allow information to circulate from one department or one team in a company to another. For instance, once the Transaction Processing System records an action, this will flow through the Decision-Support system that will be aware of this transaction and will analyse, understand and predict further actions. Once this analysis will be performed, the Executive Support Systems will be able to share the information with different level of hierarchy in the company so that everyone will be aware of the results. During this process, the Management Information System will also play its role by assigning different tasks to different people.

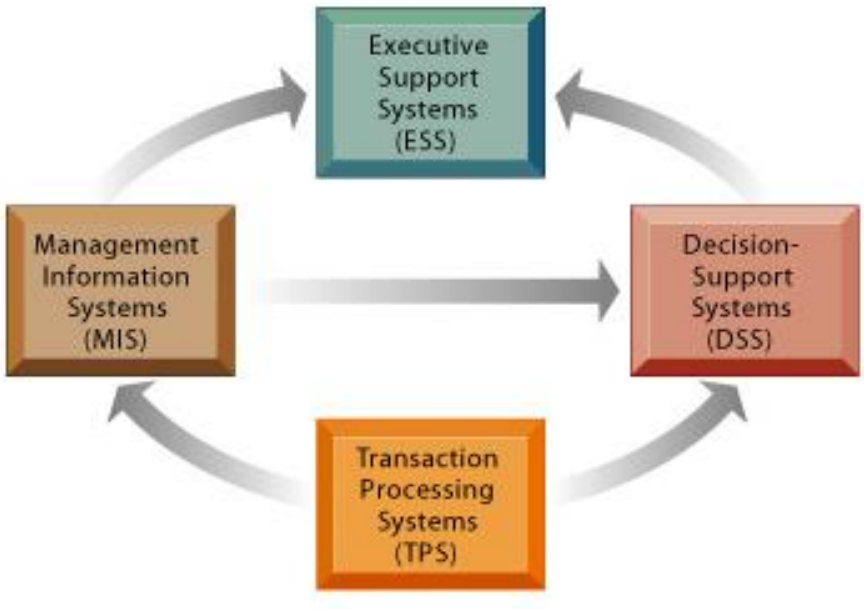


FIGURE 40: RELATIONSHIPS AMONG DIFFERENT TYPES OF SYSTEMS [MANAGEMENT INFORMATION SYSTEMS, S.D.]

More specifically and considering the cartography defined in the previous section, it is easy to identify that some systems are designed to have a general overview and are a way to connect different departments of companies while others are more dedicated to a specific field and can be seen as a sub-part of a more general department.

The system which is especially designed to have this overall overview is called Enterprise Resources Planning. This system is dealing with all aspects of the company. Indeed, the system objective is to make all resources, departments, … transparent for all members of the company. To summarize, the aim of this system is to manage and integrate all the processes of a company together.

On a lower level, but still a high-level view, it is obvious that systems such as Customer Relationship Management (CRM) systems, Business Intelligence and Analytics (ABI) systems, and Operational Database Management Systems (OPDMS) are dedicated to a wide variety of fields. Indeed, they are dealing with different departments of a company: manufacturing, sales, accounting, HR, etc. Their objectives are varied. For instance, it is clear that the different departments can be involved in a Customer Relationship Management. First, there is the Sales department which communicates with the customers. Then, there is the Manufacturing department which is also involved to provide information regarding the production, inventories, etc. Other departments can also be concerned.

These systems, interacting together, contribute to the success of ERP tools. Indeed, ERP systems are based on several pillars: Customer Relationship Management, Financial Resource Management, Human Resource Management, Business Intelligence, Production, and Inventory Management, etc (Figure 41). Creating connections between these different Information Systems is in fact the overall objective of an Enterprise Resource Planning, and, systems like CRM, OPDMS and ABI are “sub-systems” of the ERP. Without these more specific sub-systems, ERP would not make sense. [Indiamart.com, s.d.]

Let us take the following example. A salesperson registers an order using the CRM system. Based on that, the data is loaded in the ERP system. This automated transaction allows the information to flow from the sales department to others. Indeed, the ERP can circulate the information from the CRM system to the Inventory Management Systems, to the Reporting Systems, etc. Thanks to that, all operations are linked and updated at the same time, avoiding some potential loss of information, manual errors, absence of synchronization, etc. [Quirk, 2018]

FIGURE 41: ERP MODULES COMPOSITION [INDIAMART.COM, S.D.]

Going deeper into the Information Systems analysis, some systems are only designed to deal with one or a less important number of departments. These systems can be seen as sub-systems of CRM, OPDMS, BI and Analytics systems. Some of these sub-systems are mentioned in the Cartography section. There are for examples: Management Execution Systems (MES), Warehouse Management Systems (WMS), Data Quality Solutions, Data Integration Tools, Operations Support Systems (OSS), etc. They are more dedicated to specific fields like manufacturing, communication, inventory, reporting, etc. For example, MES and WMS are Information Systems that deal with manufacturing and inventory fields. Another specification of such systems is that Data Management is separated in several fields where there are Data Quality, Data Integration, etc.

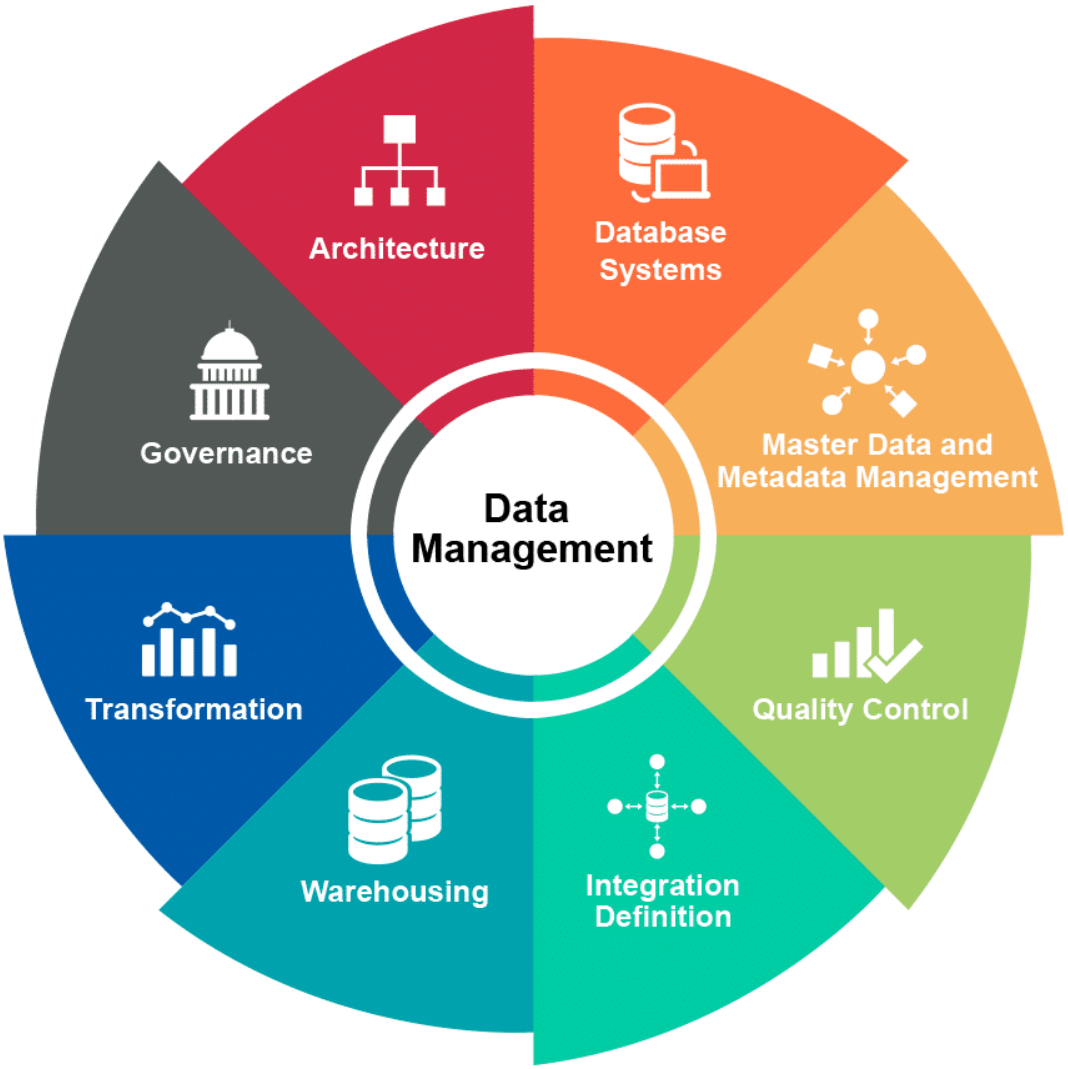


FIGURE 42: DATA MANAGEMENT SYSTEMS COMPOSITION [BLASTANALYTICS, S.D.]

The systems considering Data Quality and Data Integration can easily be linked with database systems such as OPDMS which manage the data of the whole company and with Business Intelligence and Analytics systems which analyse and create reports using the information provided. Indeed, we have the data that are registered in different databases, using some Operational Database Management Systems. Then, the Data Quality and Integration Systems are deployed to perform some actions (for example, Extract-Transform-Load). Then, the created data is integrated in a single database (called data warehouse, data lake, database, etc) which can be used to perform some Business Intelligence analysis. [*Etl Process flow,* s.d.]

For instance, imagine you have different information in different databases: sales, production, customers, etc. These elements are stored using an Operational Database Management System. Thanks to a Data Quality tool, a company is able to verify the data and keep only the correct and useful data. Then, with a Data Integration tool, the company can load the data on a single platform, creating relationships between the different elements mentioned previously. On this unified platform that will regroup all information concerning sales, production and customers, the company can perform analysis thanks to Analytics and BI tools.

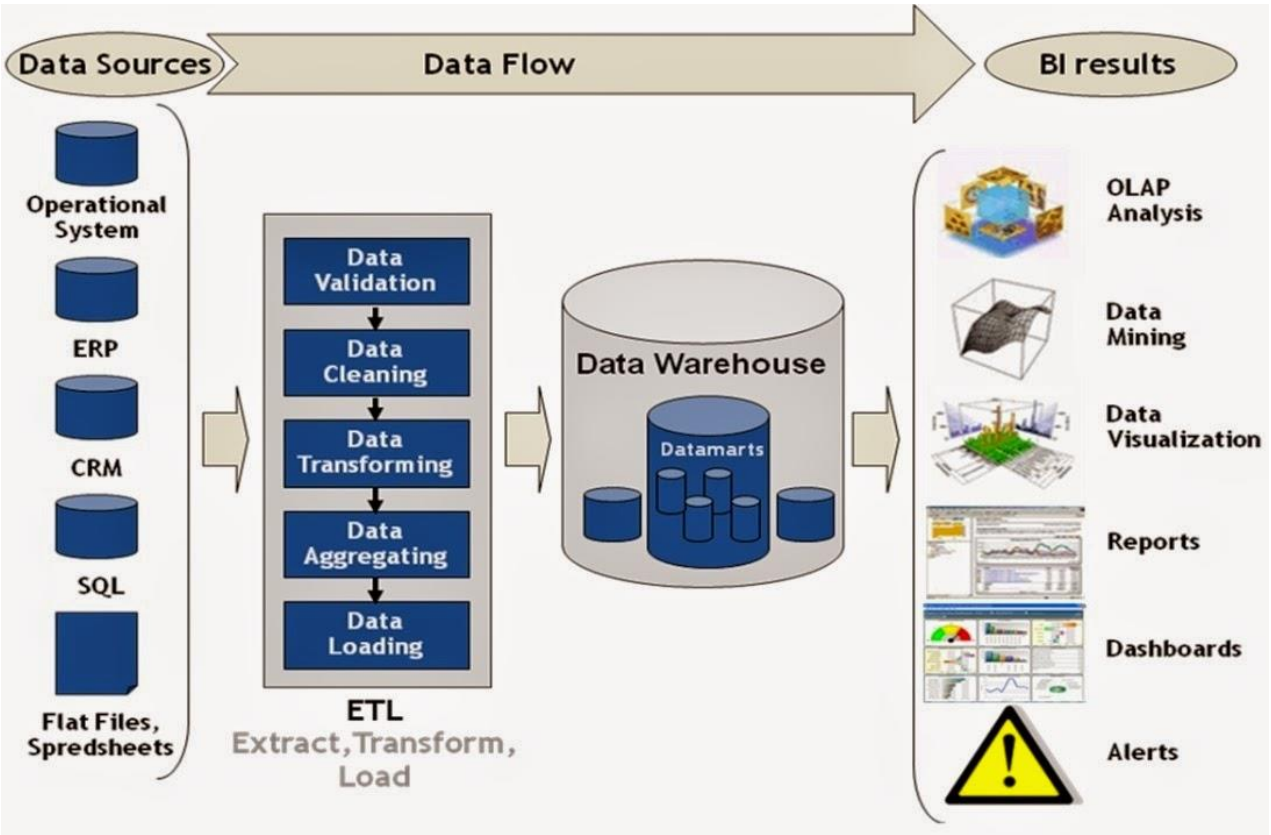


FIGURE 43: DATA MANAGEMENT SCHEMA [ETL PROCESS FLOW, S.D.]

All these interactions allow a company to be more and more automated, to have more and more optimized processes, to improve efficiency, productivity, quality, or customer satisfaction, and many other elements. Indeed, the relationships and interactions between all these information systems are key and take more and more room in companies' life. Without these digital transformations, companies cannot survive in a faster and faster changing world where more and more data are considered every day. The relations between IS are evolving quickly. A lot of these systems are currently migrating to the cloud technology, which was not especially the case before. So, we see that trends are changing quickly and that companies need to be informed and aware of all the possibilities.

11. Conclusion

To conclude this dissertation about typology of Information Systems in big companies, let us review the different elements which have been addressed.

To begin, the topic is introduced by highlighting the different elements which drive the quick and big development of Information Systems in companies, and more broadly, the evolutions that companies have to face. Nowadays, companies deal with more and more transactions, more and more data are created, and technologies are evolving which implies that the means of storing and processing information are increasing and varying.

Then, different theoretical points are displayed to clearly understand the basis of the subject. To do so, different terms are discussed. First, the term “Information” is defined, the components and types of information are described and discussed. Then, the same approach is performed with the term “System” which is also clearly defined. And, to finally close the pure theoretical aspect, the term “Information Systems” is discussed: definition, advantages, drawbacks, components, etc. Thanks to these elements, the understanding of the core concept of this thesis is facilitated.

Afterwards a special focus is given to the prerequisites of a successful Information System implementation with the sections “Audit of Information System” and “System Development Lifecycle”. A successful implementation requires several deep analyses which are discussed in the “Audit of Information System” part. The structured steps to follow in order to properly design the Information System are highlighted in the “System Development Lifecycle” part.

In the next section, the different Informations Systems are discussed according to the field they are belonging to and are classified in four categories: Sales & Marketing, Manufacturing & Production, Finance & Accounting and Human Resources. This part demonstrates the wide variety of Information System which can be linked to dedicated fields, with some relations with others at the same time. For each category, this section describes different types of Information Systems and some processes are shown to understand the way of working of such a system. The main objective of this section is to show the diversity of types of Information Systems that are available.

Then, a cartography of different Information Systems is performed to clearly identify all the existing possibilities on the market. These available Information Systems have been identified and are classified as “leaders”, “visionaries”, “challengers”, or “niche players” with the Gartner’s magic quadrant methodology. To go further in the cartography, some interesting Information Systems are more deeply described, and the main interesting providers of Information Systems are presented for different types of Information Systems. For instance, Oracle for the ERP systems, Salesforce for the CRM systems, etc. The aim of this section is to clearly state the different opportunities that are provided for companies which want to implement an Information System.

To finish this cartography and typology, some relations and links between systems are highlighted. The purpose of this section is to highlight that Information Systems are designed to have overall or specific view: some Information Systems deal with the company as whole like ERP, some Information Systems deal with different departments like CRM or OPDMS, and some Information Systems deal only with a single department like WMS, MES, etc. Moreover, the links between all these Information Systems are made to understand why there is a so big and wide offer of such systems on the market. On top of it, some kind of hierarchy is made between Information Systems to understand how they can interact and create added value in a company.

To conclude, it is important to mention that Information Systems is a topic that evolves in a quick and constant way. Indeed, some systems quickly become outdated, some face upgrades like the Database Management Systems that are now more and more dealing with Cloud technologies, etc. So, to be as coherent as possible, the most interesting systems are discussed in the cartography. That is why this cartography deals with Information Systems such as ERP, CRM, BI tools, etc.

As an extension of this cartography, it should be interesting to focus deeper on the relations between different systems and how some “sub-systems” allow the more general systems to work on the most efficient way. Indeed, the links between the systems can be useful to further understand why certain tasks are performed in companies.

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