

## ARTIFICIAL INTELLIGENCE AND THE WAY OF CHANGING DECISION-MAKING FOR BUSINESS

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### **Abstract:**

While medium and small enterprises still employ people for forecasting sales, expected revenue and further business key performance indicators (KPI), the big and high-tech companies use Artificial Intelligence (AI) to predict these indicators automatically. Thereby not only the automation of the AI system will be an advantage, even more the validity, relevance, frequency, wide data basis and 24/7 runtime are positive factors. The purpose of this research is to analyze and evaluate the human and AI decision-making systems for several enterprises within the context of Industry 4.0. To evaluate the benefit of decisions taken by humans and AI, a comparison and rate assessment is presented for the quality and opportunity aspects description. The aim of the research is to evaluate when companies should use traditional or AI decision-making processes. Research results are focused on business impact, in terms of success, in the context Digitalization and the faster changing world. Finally, clear recommendation combining human and AI decisions approaches are proposed.

*Keywords: Artificial Intelligence, Decision-Making Systems, Management, Automation, Digitalization, Knowledge Management, Business-Prediction, Industry 4.0*

## 1. INTRODUCTION

Globalization, Industry 4.0 and Digitalization are buzzwords from the past. The time is running, the business changes rapidly and the researchers, innovators and unconventional thinkers invent and develop innovative technologies which are gaining ground faster and faster. Modern technologies like AI, Blockchain technology or the Internet of Things (IoT) determine current events within the business environment. Warren Bennis, an American scholar, organizational consultant and author, said one time: “*Success in management requires learning as fast as the world is changing*” (quoted by (Kandavalli, 2014)) and “*What’s certain is that the world is changing faster than any time in human history*” (quoted by (Stephens, 2012)). Regarding this topic of faster changing conditions in every field, the managers of today and tomorrow have to make decisions regarding their business faster, more frequent and by confronting themselves with high uncertainties. Based on the digitalization, more and more data with new and additional content will be available. The following numbers of a micro-focus study illustrate these growths (Schultz, 2017):

- 3,607,080 Google searches are conducted worldwide each minute of every day;
- Worldwide, 15,220,700 texts are sent every minute
- 269 billion emails are sent daily in 2017, and this is expected to grow by 4.4% yearly to 319.6 billion in 2021;
- 1,209,600 new data producing social media users each day;
- 656 million tweets per day;
- More than 4 million hours of content uploaded to YouTube every day, with users watching 5.97 billion hours of YouTube videos each day.

These enormous amount of generated data and content in different forms has a highly impact on the decision-making processes within enterprises. This is because in the databases might be a lot of useful information for a successful business decision which would have to be considered. Nevertheless, it can be argued that half of the decisions made by managers within organizations fail (Ireland & Miller, 2004). Therefore, effectiveness of the decision-making processes is an important aspect of exploiting managers’ (as decision factors) efficiency and success within the business processes.

In this context, the following research examined the different methods of decision-making systems and approaches within the time of digitalization. Next to the conventional approach, the use of AI as a decision-making system will be analysed and evaluated. As foundation, the important terms of the study will be described in detail and set into account to framework conditions. To evaluate the different approaches there has been proposed an assessment to find the most adequate decision-making system and their required framework of parameters for successful decisions. The result will support managers to think about their decision-making process and the implementation of using innovative technology to support decision making.

## 2. SCIENTIFIC BASIS OF THE RESEARCH

### 2.1. Definition of the Decision-Making Process

The decision is the conscious choice of alternatives. Sometimes the quality of the decision depends largely on coincidence and if several people are involved, possibly on their positions of power (Birker, 1997). Decision making describes the ongoing processes of evaluating situations or problems, considering alternatives, of selecting the best choices among diverse options, and following them up with the necessary actions (Vu, 2014).

The effectiveness and quality of the taken decisions determine the successfulness of a manager and therefore the company. One key precondition for the entire decision-making process is the availability of the right information to the right people at the right time (Harcourt, 2016).

### 2.2. Types and Level of Decision

Decisions are made regularly in different expressions and with distinguish consequences. When a manager or direct takes decision as an executive in the official capacity, it is known as organisational decision. The authority of taking organizational decisions may be delegated, while personal decisions cannot be delegated (Chand, NN).

The literature distinguishes between the Programmed decisions and Non-programmed decisions. Programmed decisions are concerned with repetitive or routine type problems. A standard procedure is executed for solve such problems. The automated response to make these decisions is called the decision rule. Decisions of this type are e.g. supply of goods, purchase of raw material, and granting leave to an employee and so on (Kontz, 2010). Decisions that are related to difficult circumstances, unique and with a high impact require conscious thinking, information gathering, and careful consideration of alternatives, these are called non-programmed decisions. These kinds of issues or aspects are very important to be considered in the case of an organisation and they are usually analysed at the upper and top-level management (Kontz, 2010). Examples are the opening of a new branch, introducing new product in the market or a crisis for a company. A summary of the presented aspect are shown in Table 1.

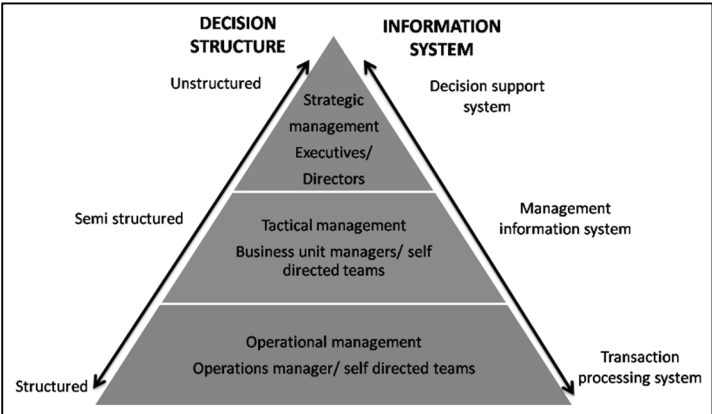
**Table 1:** Programmed and non-programmed decisions – short overview

Characteristics	Programmed Decisions	Non-programmed Decision
Type of problem	Structured, routine, well-define	Unstructured, novel
Managerial level	Middle / lower level	Upper / top level
Recurrence of problem	Repetitive	Non-repetitive, new, unusual
Judgement	Objective	Subjective
Information	Readily available	Ambiguous or incomplete
Time frame for the solution	Short	Relatively long
Solution relies on	Procedures, rules and policies	Judgement and creativity

Source: authors own development

Decision making can be of three categories. The *strategic* decisions which set the course of organization and develop overall organizational goals, strategies, policies. The *tactical* decisions are decisions about how things will get done and the *operational* ones which are decisions taken by employees each day in order to run their processes (Montana, 2008). These levels of decision can be merge to the “*Levels of Management Decision Making*” as mention in the research of O'Brien and Markus (2011) and as it is illustrated in Picture 1.

**Picture 1:** Levels of management in the decision-making process



Source: O'Brien, 2011

The picture displays the different hierarchy level of decision making within a company regarding the decision structure and information characteristics. It can be recognized, that with the increasing management level the decision-making process will be developed in conditions of higher uncertainty, as well as their impact will be with higher risks (Kontz, 2010).

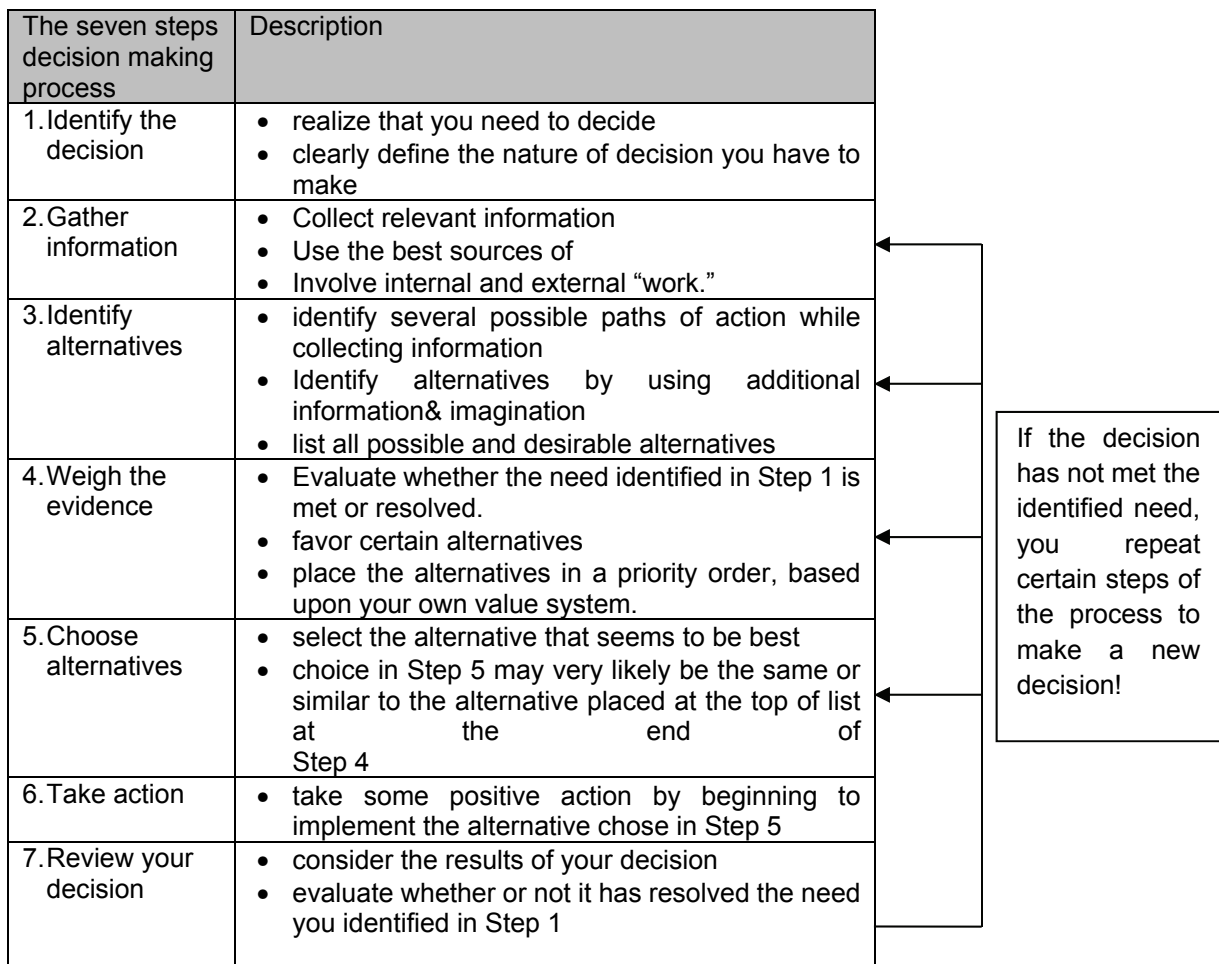
### 2.3. Definition of the Decision-Making Process

Baker (2011) considered that “*efficient decision-making involves a series of steps that require the input of information at various stages of the process, as well as a process for feedback*”. The literature and science distinguish between 5, 6, 7, 8 and even 9 steps of the decision-making process. The reason is because each manager adopts a different decision-making model to evaluate his/her choices in order to reach the final solution (Harcourt, 2016).

In the context of this research, there has been considered seven steps decision making process, as supported by the previous work of by Birker (1997) and Brown (2007) and as it is most commonly applied in organizations’ practice. The use of a step-by-step decision-making process help the managers to do thoughtful and evaluated decision by organized and relevant information (Montana, 2008). Like illustrated in the following Picture 2, the seven steps with brief description can be seen. Science also calls this kind of decision-making process, rational decision-making process. Next to the rational model, three further decision-making models exists (Verma, 2009):

- *Bounded Rationality* – using by minimal clear criteria, less time to take a decision;
- *Intuitive* – unclear Goals, time pressure, expensive analysis, experience with the problem;
- *Creative* – Problem solutions are unclear, new solutions need to be generated, time to analyse.

**Picture 2:** Decision-making process



Source: own synthesis from (Birker, 1997) and Brown (2007)

### 2.4. Decision Support Systems

A Decision Support System (DSS) can be defined as a specific class of computerized information application that supports business and organizational decision-making activities by analyses and prepare business data to present it so that business decisions can be made more easily. A DSS is a system that compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions. DSS don't replace the judgements, there only extend the capabilities of the decision makers. To make this work many applications are necessary and work together (Zhang, 2015). These applications can mainly be grouped in: Management Support Systems, Operation Support Systems and Data Bases (O'Brien, 2011). Within the literature five different classifications regarding the mode of assistance of the DSS can be deducted like displayed within the Table 2.

**Table 2:** DSS Types by Power

Type of DSS	Definition
Communication-driven	Support more than one person working on a share task by the use if a tool
Data-driven	Emphasizes access to and manipulation of time series of internal company data and external data
Document-driven	Manages, retrieves and manipulates unstructured information in a variety of electronic formats
Knowledge-driven	Provides specialized problem-solving expertise stored as facts, rules, procedures
Model-driven	<ul style="list-style-type: none"> <li>• Emphasizes access to and manipulation of statistical, financial, optimization or simulation model</li> <li>• Use of data and parameters provided by users to assist decision makers in analysing a specific situation</li> </ul>

Source: own development

## 2.5. Artificial Intelligence

AI can characterize by the list of different application and work areas, for example in the following (Cleve, 2012):

- *“The theory and development of computer systems able to perform tasks normally requiring human intelligence”;*
- *“The AI examines how to capture and understand the intelligent behaviour of computers, or how to solve problems by using computers that require interoperability”;*
- *“AI is a subdivision of computer science, which deals with the investigation of different problem areas like robotic, speech and flow text recognition as well as image and video processing”.*

For the scope of this paper AI is defined as a section of informatics and applied computer science to pattern human proceedings of problem-solving and transferring them to computers to invent efficient and new solutions as well as new course of actions. Therefore, AI is a computer program running on any possible device or data centre with the skill to interact with its environment and solve programmed tasks (Paschek, 2017). Furthermore, AI will be seen within the context of information gathering via Big Data and the evaluation of these data.

## 2.6. Evaluation of the scientific status

The theory shows the variety of definitions and models in the field of decision-making process. In a nutshell a decision support system prepared and synthesized relevant data and information from different internal and external sources and present them graphically, too. In the present time of digitalization, Big Data technologies and AI supports the preparation and decision-making process with the aim of less uncertainty and lower risks for business executives or some other group of knowledge workers. Typical information that a DSS gather and presents are (Power, NN):

- Accessing all information assets, including legacy and relational data sources;
- Comparative data figures;
- Projected figures based on new data or assumptions;
- Consequences of different decision alternatives, given experience in a specific context...

Within the context of this research AI combines fuzzy logic systems, Expert Systems, Artificial Neuronal Network Systems as well as Algorithm Systems.

### 3. THE RESEARCH METHODOLOGY

To analyse the practical relevance of AI support for the decision-making process the survey method was used. The survey was online based which provided the participants with the opportunity to execute the 60 questions any time. The survey started with the introduction of the topic and the objective. After this socio-demographic data about the respondent was asked e.g. the age of the person, management level or part of a decision instance. Furthermore, general company information like the amount of employee or business model and customer groups were asked too. The core of the survey dealt with questions to examine the status quo regarding the knowledge and utilization of any Decision-Making-Process as well as the use of DSS and AI. Furthermore, the questions focussed towards the decision makers which way they work with data and information as well as changes through the digitalization and their opinion regarding Big Data. All the Answers were related to the uncertain and high-risk decisions. The used types of questions were dichotomous questions, grouping and rating questions like the Likert Scale as well as open questions to get further information and feedback from the participants.

In the target group were considered small and medium enterprises from Germany because of the assumption that big enterprises already use established decision-making processes with AI support. 400 companies with digital business models were selected to receive an email with the link to the survey; 63 complete responses (valid on-line questionnaires) were processed and for the results generation. The target persons were mainly Chief Information Officers (CIO), Chief Technology Officers (CTO), Chief Execution Officer (CEO), Chief Digital Officer (CDO), Chief Automation Officer (CAO), IT process managers as well as Human Resource Managers (HRM); they have been considered to elevate the opportunity to use AI for the decision-making process because they have experiences in these field.

#### 3.1. Results of Study and Assessment

In the following, the main results of the online survey are presented. 15.75% of the 400 companies support with answering the whole survey. From that 41 small enterprises with less than 10 million Euro revenues and 22 medium enterprises with more than 10 and less than 50 million Euro revenues participated at the survey. The 63 responses are given by 28 CEOs, 18 Managers on duty, 11 CIOs and 6 CAOs. In Picture 3 the key findings of the survey are outlined. All surveyed companies are using Transaction Processing Systems as operational support application to detect their business processes.

Picture 3: Survey results



Source: own results

Still 61 companies are using a Management Information Systems for steering the business units and departments on top of Transaction-Processing-Systems. But only 62% of the surveyed companies use Decision-Support-Systems for strategical management and overarching decisions. With a view to the state of the art technology only 8 companies indicate to have experiences with AI. Reasons for this are mainly uncertainty with AI and use cases for execution and support as well as missing skills and resources to implement within the company. For these reasons all surveyed enterprises don't use AI within their DSS.

For all participants the data basis as well as the existing and prepared knowledge next to the external influencing factors are crucial. Based on this finding, all surveyed outlined the use of an internal knowledge management system with several information and technology support levels. Regarding the exceptions of using AI for DSS the following three are most relevant and given by a free text field.

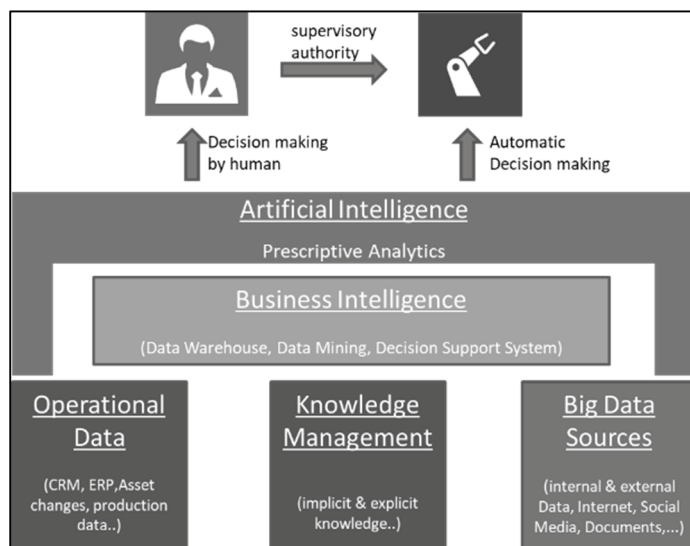
- Better preparation and analysis of existing data for a faster decision-making process;
- Better handling of multiple information sources;
- Less uncertainty by more information and a better risk assessment.

Regarding the position of management of the surveyed people no correlation could be identified. This can be attributed to the fact that the companies are organized by a low hierarchy as well as a short way of decision within the management. This point should be analysed within the relation to big enterprises.

### 3.2. Implementation and Execution of DSS with AI

After the survey assessment take place three of the eight companies with AI experience and a DSS were interested in implementing and execution of DSS with AI support. Regarding skills and know how as well as available resources the planning and implementation took place within a small company and the support of an external consultancy. The analysis, design and on boarding process took 2 months with a minimal viable solution approach and six months to a complete implementation with an integration of all data bases and the Business Intelligence framework. The simplified process structure and architectural implementation can be seen in the following Picture 4.

Picture 4: DSS and AI implementation approach



Source: authors own schema

There simplified three types of “data bases” are depicted with connection to the adapted and extended Business Intelligence System as synonym for the Decision-Support-System. As frame the Artificial Intelligence unit symbolises the prescriptive analytics part for the transition and editing of the findings for the automatic decision-making on the one hand and the manual decision making by human. The implementation approach as well as the implementation will be part of a future scientific work.

### 3.3. Results of the implementation

The implementation and deployment of the AI component as well as the enlargement of the existing DSS with a wider Data basis and more structured knowledge management led to improved management decisions. For the assessment of improvements as well as deteriorations regarding the new face to face survey take place after 3 months of working with the system. Target groups of this survey were all people with direct impact and touchpoints to the decision-making process. These 9 people were asked separately to get an individual evaluation. For the final analysis and evaluation, the individual results are combined to get an average result for the company. The main advantages of the implementation are:

1. 24/7 data and information gathering, processing and evaluating and preparation for decision without any human, which led to skill shifting and resource savings and *less costs*;
2. Calculus of probability as basis to suggest or take the best possible decision with a concrete factor of uncertainty and manageable risks led to *35% less bad business decisions* as opposed to before;

3. Less human weakness by feelings, emotional habits and concentration on clear facts led to *more revenue*;
4. Identification of customer and product correlations which led to *better sales activities, more revenue and a higher customer satisfaction*.

On the other side the participants reported the following disadvantages:

1. Automatically decisions by the system should be approved by human to avoid to early or not strategic actions;
2. If the algorithm are not correct, wrong decisions and calculations were made from the system;
3. Not only hard business facts and figures count, human behaviour and emotions must be considered by business decisions whereby the decision-making process.

### 3.4. Pre-Conclusion

The usage of DSS within small and medium enterprises are helpful to review the mass of data and information's to work out decisions. Nevertheless nearly 30 % of the surveyed companies don't use DSS in times of digitalization which can be a strong disadvantage towards competitors. The implementation and usage of AI shows a lot of advantages and a clear positive business impact for the analysed company. Next to savings due to decisions not made the revenue could be increased by 15% as well as the customer satisfaction rate increased by 9%. This show the potential of data analysis and decision support by AI. Next to this the implementation cost must be consider as well as the missing human habits and emotional decision factors within the world of business. Not all decision can be taken by hard facts, sometimes human factors have a relevant impact regarding decision. Summarizing AI for DSS helps the business to take fundamental decisions by less uncertainty and risks.

## 4. CONCLUSION

Every person has to make many decisions on a daily basis, and the decisions range is very wide from simple ones to more complicated as well as complex and important decisions. For manager of a company, decision making is important and responsible task because his decision influence his employees and can even change the course of a company. For this reason, the decision-making process as well as the decision support tools should play a key role within a company and the management level. More and faster generated data every month in times of digitalization and globalization lead to faster changing markets. To generate relevant advantages towards competitors the relevant data have to be collected, analysed and processed as information regarding the own business decisions. Summarized AI in combination with DSS and good data sources will have a positive impact towards the business decisions of a company within the time of Industry 4.0 and 5.0.

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