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An Analysis of the Decision-Making Process from a Mathematical, Socio-Psychological, and Managerial Perspective

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Abstract

The main purpose of this article is to give a coherent and unified vision regarding the main obstacles that characterize the decision-making process purely form a managerial point of view.

During the following argumentation the main topic will be analyzed from three different, but at the same time strictly interconnected, perspectives, with a mandatory description of the general environment that surrounds the decision as a prelude.

The discussions written in this particular article follow a simple thread, firstly a general description about how the decision-making process is made, with the purpose of aligning the potential reader to the basis of the topic. Then, it will follow a diachronic path, discussing about the main obstacles in the process in connection with the human being, firstly as a solitary entity, and then as a group involved in the decisional process. Henceforth, in the discussion about the decisional obstacles the attention is shifted towards the other and more modern half of the pie, discussing about the mathematical categories of instruments that aim at supporting, and sometimes taking over, the decisional process, and obviously also of its limitations and specificities. Lastly, in the final section both, mathematical and socio-phycological facets, are reunited into the managerial domain, with the purpose of showing the ratio behind the different managerial decision instruments.

An introduction to the Ideological Decision-Making Process

In the common literature it is possible to find different ideological paths that try to outline, define and categorize the logical process behind a decision. In general, it is possible to define four different phases that are needed as a starting point for an ideal problem-solving process, independently form the complexity of the problem itself.

It is possible to say that usually every decision-making process should start with the action of framing the problem (Chevallier A., 2016). Intuitively form the name, the purpose of this first phase is to define and outline the exoskeleton of problem in order to have an excellent starting point. This particular phase is defined by two main steps, the first one consists in a description of the problem, defining the frame in which the problem exist with the purpose of avoiding possible misalignment with the wanted goal. As regards the latter one, it consists in the delineation of the frame of the diagnosis. In this step the connection between the situation, that is referred to center of interest in the considered

portion of the universe, and the complication, that is referred to the particular problem encountered as regards the previously defined situation, is made.

After the needed framing the following phase is the definition of the causes. In this phase it is firstly identified a series of potential root causes that could have led to the problem, and only then, with the use of particular criteria or instruments (such as Bayesian inference), the actual root causes are extrapolated from the potential ones. It is necessary to bear in mind that the definition of the potential and actual causes is strictly influenced by the environment that lies around the problem solver, consequently actual causes can differ from real actual causes.

Intuitively, after the definition of the actual causes the next logical action is to define the possible alternatives that fits between the cause and the wanted outcome, and consequently choose the best ones, it is here that the effective decision is done.

The last phase of the entire process consists in the effective implementation of the problem and in the monitoring of the problem environment. It is important to remark that the latter step can be considered one of the more neglected and important ones as uncertainty, risk, and various errors, both human and non, can influence, to some extent, or even totally the final outcome (Chevallier A., 2016; Anntoinette D. L., Lepsinger R., 1997).

The Socio-Psychological Facet

Before starting with the discussion about the various obstacles introduced by the presence of the human being it is necessary to integrate the previous description of the decisional process. Differently from the ideal decision-making process, in a real world the effective decision is the result of the interaction between different forces (Kayser A. T., 2011), forces that sometimes pull towards the best analytical decision, but sometimes not. Intuitively, these forces act at different levels of the decision process, at the more internal level it is possible to say that the decision outcome is mainly driven by two forces: the quality of the decision, that indicates how much the chosen alternative is better than the other ones, and the relative acceptance of it. At a step above it is possible to find the time pressure, that defines the time frame in which a decision needs to be made. In the higher, and last, step two important forces are influencing the final decision: the forces within the decision-maker (its knowledge, personality, and biases) and, where present, the forces within the group that surround or even composes its figure. These two forces are the ones that will be further discussed in this section.

The first pillar of the managerial decision-making can, without a doubt, be associated with the human element, with its biases, irrationalities, behaviors (Drummond H., 2012). In the history of the human being almost the totality of the decisions was made by a human, banally because there was no other possibility, and also if in the last decades there was a shift towards a more automated and feelingless decision-making, nowadays humans continue to play a big role in decisions.

The human being is a complex, wonderful, but also imperfect machine, able to adapt itself to an almost infinite series of situations and to bend its environment to achieve a series of goals, but also incredibly able to make an easy decision a harder one and consequently getting it wrong (Drummond H., 2012; Moore D. A., Bazerman M. H., 2009). As regards the psychological obstacles encountered by humans it is possible to outline a series of different categories, each one with its peculiar characteristics. First of all, it is necessary to say that these obstacles are not presented in the same way by every decision-makers, as a matter of facts the presence or not of these obstacles and its intensity could vary from person to person, and also from time to time.

In general, as regards this particular topic it is possible to outline eight different negative effects that, if presents, could lead to bad decisions. These effects are known as: overconfidence, confirmation, anchoring, analogy, availability, vividness, instant-response, and expectation.

As the name suggests, the overconfidence effect, as the name characterize a scenario in which the level of confidence of the decision maker can be considered higher than normal. Intuitively this situation could lead to wrong decisions as it is easier for a highly confident decision-maker to

overestimate their ability with a possible under evaluation of critical decisional variables such as uncertainty, risk, and possible bad outcomes.

As regards the confirmation effect, it is referred to the particular behavior for which the attention of the decision-maker, during the research of information, is shifted towards positive information that confirms his/her ideas rather than negative one, leading to a better, but at the same time distort, vison of the decision environment.

Another two important negative effects that could affect the decision maker are the anchoring and the analogy effect. The first one can be associated with the susceptibility, during forecasting or in general prediction events, of the decision-maker to external stimulus provided by the surrounding environment. As a result of this effect these stimuli are unconsciously picked by the decision-maker and used as a starting point for the future predictions. As regards the latter one it happens when a previously defined solution for a particular problem is applied to another problem, generally similar to the first one but different in the details. Intuitively, this could lead to misunderstanding and missing critical information about the problem environment.

The availability effect can be defined as that particular effect for which, in the mind of the decision-maker, recent events have a greater weight than less recent ones and, for this reason, are intrinsically treated as more important or valid, obviously with a consequent distortion for the decision environment.

Under a particular point of view, the vividness effect can be considered as similar to the availability one, this because, also in this case, different weights are applied to different information through the use of a non-rational criteria. As a matter of facts this effect push the decision-maker to remember more vividly events that carry strong stimuli such as a person dressed with in red in a smoking and tie party, or the crash of a train seen at the local news. Intuitively this could generate a false perception as regards the probability distribution of certain events, increasing the likelihood of errors.

At the last, in order to close the circle on the psychological limitations, it is necessary to define two more obstacles, the instant-response and the expectation effect. The first one can be correlated with every decision made based not on the logic but on a particular mood, or more in general on emotions (Drummond H., 2012). In a day to day life it is possible to see a lot of examples of this effect as a great chunk of the daily decisions taken by a person are influenced by this, just think at the purchasing of candies or chewing gum while waiting for the check-out in a supermarket. As regards the latter one it is referred to the tendency, for the decision-maker, of forcing a rationalization and alignment of the information with the unconscious purpose of justify and strengthen previous explanations or decisions, obscuring the reality, and the possible acidity, of the facts.

It is worth to notice that the boundaries of these negative effects are not sharp as presented in the previous discussion, it is more likely that these (and many others) effects will work in combination with each other's and with the particular personality of the decision-maker, producing unique outcomes. Obstacles to decisions are lurking even so close to the decision-maker, originated by someone that should be the person you think you know best, yourself.

Once outlined the living environment that surrounds the psychological decision obstacles the attention can be shifted towards the sociological one or, in the decision-making scenario, the dynamics inside a team. Team dynamics, as regards decision-making, can be considered a very complex argument as an obvious consequence of a high presence of mandatory interactions between two or more people.

The first step towards the understanding of the dynamics that shapes every group decision-making scenario starts with the understanding of the power element and its role inside a team. Here it is necessary to distinguish between harsh power, or the power originated by the particular structure of the team, and soft power, originated by the peculiar characteristics of each team member (Levi D., 2017).

As regards soft power it is usually derived from the effective knowledge of a person in some particular field, by making the other teammate perceive some sort of expertise in the field interested be

the future decision or by been admired and respected by the others group members. Harsh power instead is usually originated in connection with the particular positional power such as a higher level in the hierarchy or with the power of giving rewards or punish certain behavior. It is worth to notice that a huge role in weighting the two different types of power is played by the decision structure, is it autocratic, where only one person can decide, consequently increasing the harsh power of the decision-maker and reducing the possible influence of the other people, or shared between team members. It is worth noticing that in general, thanks to its characteristics, soft power results more effective between the two, this because hash power is also strictly correlated with factor of culture and perception of power from the surrounding people.

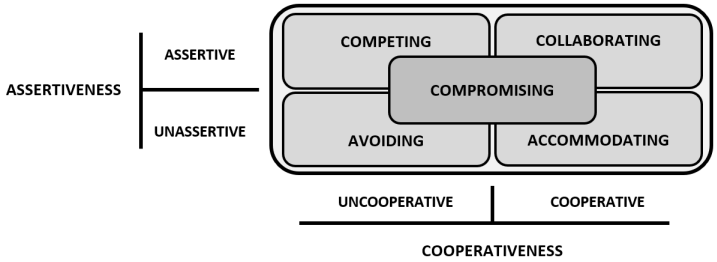
Discussing of team dynamics and obstacles to the decision process, it is also fundamental to take into consideration the possible presence of self-oriented roles or the groupthink symptom. As a matter of fact, these two elements can easily undermine the solidity and effectiveness of a team, reducing or even deleting its possible benefits (Aldrag J. R., Kuzuhara W. L., 2015).

Talking about the first category, or self-oriented roles, it comprehends all the roles verting around a particular, but not unique, selfish vision about their role inside the team. Usually it is possible to categorize them in freeloaders, known to not carry a fair share of the workload, complainers, that constantly complain for any reasons consequently reducing the team morale, bullies, that actively try to force their opinion over the others, and lastly martyrs, which think that are the only people to do something in the team and for the team.

As regards the latter element, or groupthink, it can be defined as an excessive form of concurrence-seeking among the team members that position the values and beliefs of the team over anything else (Hart T. P., Irving L., 1991). This particular symptom can generate situations where the team members feels the illusions of invulnerability and unanimity of the group, where a collective rationalization leads to self-censorship of possible contrasting ideas to the main belief, and, more importantly, to situations where people outside the group are stereotyped, classifying their opinions as not valid as the ones inside the group. Obviously, it is pretty straightforward that a group behavior like this cannot leads to a healthy group environment, as a matter of facts the common drawbacks of this are an incomplete surveys of alternatives, a poor information search and also selective bias in processing the limited information acquired, failure to examine a preferred choice and also to reexamine rejected alternatives, and lastly failure to develop valid backup plans in a scenario where the actual outcome differs from the planned one. It is necessary to bear in mind that this particular bias act in harmony with all the other obstacles it is easy to deduce why preventing this effect is not an option but a necessity for the team.

The Last piece that complete the team dynamics puzzle can be associated with team conflicts. Broadly, it is possible to outline two different types of conflicts: interpersonal, that can be defined as conflicts between team members as a consequence of different ideas on the correct path that should lead to the decision, and more importantly task conflicts, associated intuitively with different ideas as regards the execution of team tasks. As regards the settlement of the conflict it is possible to say that it depends on the different conflict styles (or different behavior) of each person participating to the discussion. The logic behind the definition of these styles is based on the combination generated by the presence or not of two different elements, assertiveness and cooperativeness (Aldrag J. R., Kuzuhara W. L., 2015). As represented in the following figure the combination of these two elements generates five different conflict styles: competing, avoiding, collaborating, accommodating, and lastly compromising.

Figure 1: Conflict styles



Intuitively, the meaning of these five styles it is easily deductible from their name, less deductible instead is the situation generated by them. Where for competing and accommodating styles a win-lose situation is created, usually win for competing and usually lose for accommodating, for the avoiding there is a lose-lose situation and for the collaborating there is a win-win one. Each type of conflict style carries with itself a different level of commitment and also a different type outcome that can range from optimal to disastrous. It is worth to bear in mind that team conflicts are an unavoidable, and also decisive, component that shapes every team, if managed correctly conflicts are what permits teams to improve, but if not, they can easily push the team to an internal collapse.

The Mathematical Facet

The second, but not for importance, pillar is the mathematical one. This particular pillar can be considered as the educated guess of the decision-maker towards the rationalization of the decisional process by moving the greatest possible component of the problem inside the mathematical world, known to be built upon multiple coherent and well-defined rules.

Unless the presence of particular mathematical skills of the manager, the entire process of rationalization is made by a separate figure from the decision-maker known as modeller, that, starting form particular inputs (variables) from the decision-maker, generates a specific output that should give a rational solution to the problem.

It is obvious that the previous definition is made upon a series of oversimplified assumptions that cannot fully coexist with a real-world scenario. The first reason for this is because, as said before, decision-maker and modeller are usually not the same entity, possibly leading to al the obstacles discussed in the socio-psychological facet such as misinterpretations, bias, conflicts. Another reason can be associated with the complexity of the decision environment. As a matter of facts, in most of the cases, it is impossible to convert the entire problem in input variables for the mathematical model leading to choose only a small portion of it to be analyzed and elaborated by the model (Finlay N. P., 1985). Lastly, intuitively, building a model require time, and time is a scarce resource in a real-world scenario. A model usually needs to be tailored for the portion of the decisional-problem, this because it permits a more reliable output based on specific inputs, consequently leading to a greater need for time.

Also if mathematical modelling is not the panacea that can solve every obstacle and give always the right answer, it can equally be considered as a useful instrument. As a matter of facts nowadays there are a huge number of different mathematical forms that can be generally grouped in three different categories. For what concerns the first category, or deterministic decision-making, is possible to find all the models that need strong assumptions to exists and that, for this reason, are used only in scenarios where the output can be reliable also if irrationality, uncertainty and risk are not taken into consideration (Monahan E. G., 2000).

Differently form the first one, the second category, that is constructed upon the decisional theory, is characterized by the consideration of additional variables, such as risk and uncertainty, that contribute to give a more faithful representation of the environment consequently increasing the range of possible application of the mathematical solutions.

As regards the last category of models, or Multi-Criteria Decision-Making (MCDM), it is possible to say that here are the mathematical instruments to be applied to the real-world rules and not vice versa, opening an infinite series of possibilities of interpreting the environment.

It is worth to notice that every one of these categories of models work best in the specific environment for which they are built for, and that these instruments represent only a portion of the entire set of mathematical ones that can results useful in a decisional scenario.

For what concerns the deterministic decision-making category, the most common, and also predominant, typology of models is the Linear Programming (LP) one. The procedure through which these types of models are able to optimize the final outcome is by maximizing (or minimizing) a specified variable but, at the same time, satisfying a series of limiting conditions. Moving towards the algebraic domain, a general LP problem can be mathematically represented as follows:

$$Max(Min)\ X_0 = \sum_{j=1}^{r} C_j X_j$$

Formula subject to restrictions:

$$\sum_{j=1}^{r} A_{ij} X_j (\leq, = or \geq) B_i$$

i = 1, 2, …, m $\qquad X_j \geq 0 \qquad$ j = 1, 2, …, r

Where j (j = 1, 2, …, r) are the several activities that share Bi (i = 1, 2, …, m) limited resources. Aij represents the usage of the jth activity from the ith resource, with the output of that particular activity represented by Cj, and lastly Xj indicates the value that needs to be optimized (Chapman S. C., Hopwood G. A. Shields D. M., 2007; Hiller S. F., Lieberman G. J., 1995; Moder Joseph J., Elmaghraby Salah E., 1978).

As said in the introduction of the mathematical facet, linear programming models are subject to a series of assumptions that conditionate their existence and the reliability of its outcome. These assumptions are translated mathematically in three different statements: Proportionality, that indicates that the usage of resource and the contribution of an activity is directly proportional to its level, additivity, for which the cumulative usage of resources is equal to the sum of all the resources used by each single activity, and lastly non-negativity that defines that the result of the linear function for a specific activity can only be positive.

Analyzing the previous assumptions, it is obvious that linearity is rarely satisfied by real-world problems. In these situations it is possible, through the use of particular instruments such as quadratic programming, fractional programming, integer LP, min max criteria and more, to approximate a general system, making feasible the application of LP formulations.

At a first glance, it could seem that these instruments cannot be a valid comprehensive alternative for a decisional problem, but it is always necessary to take into consideration the price of the perfect solution and the time constraints as well. An approximative, but reliable, answer given inside the time limits is always better than the best answer received outside the time frame. As a matter of facts linear programming instruments are used to solve a vast amount of different problems, cutting stock problems, Product mix problems, staff scheduling problems, capital budgeting problems, blending problems, network flow problems are only a few solved by these models.

Moving towards the second category of mathematical instruments, the groups what concerns decision-making as regards of the decision theory perspective, it is possible to find a series of tools optimized to deal with two central problems introduced with this particular vision, uncertainty and risk. At a first glance, risk and uncertainty could seem the same entity that brings with itself a similar definition, instead this definition can be only partially applied since they carry a similar concept adapted in substantially different environments. For risk is taken into consideration an environment permeated with an objective structure that dictate the rules under with the outcome is determined

whereas for uncertainty the previously defined objectivity is replaced by a set of subjective, sometimes not known or defined, rules that fades the boundaries of the problem environment. (Brandimarte P., 2011).

As regards scenarios where uncertainty cannot be neglected and the rules of probability cannot be fully applied, it is possible to outline three different instruments able to give a help: the Maximax criterion, according to which the right choice is the one that maximizes the hypothetical profitability between the maximum payoff for each alternative the Maximin criterion, that outlines among the worst alternatives the one with the maximum payoff, and Minimax regret criterion, that is oriented to minimize the maximum opportunity loss.

Maximax criterion

$$f(V) = \max_{i=1,2,\dots m} \max_{j=1,2,\dots n} \mathrm{V}(D_i, S_j)$$

Maximin criterion

$$f(V) = \max_{i=1,2,\dots m} \min_{j=1,2,\dots n} \mathrm{V}(D_i, S_j)$$

Minimax regret criterion

$$\mathrm{L}(D_i, S_j) = [\max_{i=1,2,\dots m} \mathrm{V}(D_i, S_j)] - \mathrm{V}(D_i, S_j)$$

$$f(V) = \min_{i=1,2,\dots m} \max_{j=1,2,\dots n} \mathrm{L}(D_i, S_j)$$

For what concerns risk, it is possible to fully associate each state of nature with a specific probability that must follow the rule for which the sum of all the probabilities associated with each alternative needs to be equal to one, consequently leaving no space for uncertainties in the representation but, at the same time, permitting the application of the logics belonging to a Bayesian environment (Horowitz I., 1990; Karni E., 1985).

As regards the criteria dedicated to the evaluation of a decision in an environment subjected to risk it is possible to outline three different fundamental formulas: the Monetary Expected Value (MEV), that consists in the evaluation of the expected mean monetary returns for each alternative, the Expected Value of Regretted Opportunities (EVRO), that has the purpose to minimize the opportunity loss for each decision, and lastly the Expected Monetary Value of Perfect Information (EMVPI), that defines the monetary value that the decision-maker needs to spent to obtain perfect information about the alternatives.

Monetary Expected Value

$$MEV(V^*) = \max_{i=1,2,\dots m} \sum_{j=1}^{n} P(S_j)\, \mathrm{V}(D_i, S_j)$$

Expected Value of Regretted Opportunities

$$EVRO(V^*) = \min_{i=1,2,\dots m} \sum_{j=1}^{n} P(S_j)\, \mathrm{L}(D_i, S_j)$$

Expected Monetary Value of Perfect Information

$$EMVPI = \sum_{j=1}^{n} P(S_j)\, \mathrm{V}_{max}(S_j)$$

Note that $f(V^*)$ = Represents the optimal value.

It is useful to notice the similarities between the two criteria connected to the uncertainty scenarios and the two connected with the risk ones, but also it is worth to notice the differences between them, such as the role of the probability P (S_j) in a risk scenario (Borek A., Parlikad A., Webb J., Woodall P., 2014).

The last category of mathematical instruments discussed in this article is the Multi-Criteria Decision-Making (MCDM) one. As said before this particular category offers a different vision about

the logic used to solve a problem and consequently also a different vision about the relationship between mathematical and real problem environment. This imply a shift form a distributive vision to an integrative one where multiple, general conflicting, objectives are taken into account and evaluated with different, tailored, criteria. (Goicoechea A., Duckstein L., Zionts S., 1992; De Buryn C., Colson G., 1989).

As regards this particular category of instruments, in the history of the literature, different models were proposed, some of these are the Analytic Hierarchy Process (AHP), designed to evaluate a set of alternatives organized in a hierarchical structure through the use of multiple criteria (Fox W. P., 2018), ELECTRE I, that has the purpose to aggregate different performance table in a choice set, Multi-attribute Value Theory (MAVT) that compares and evaluates preference relations, and TACTIC, a slight variation to the ELECTRE method that aggregate different performance table in a global performance relation, just to name a few. As it is intuitable, each model has its unique specificities, techniques to apply a mathematical vision, and fields of application in which it can maximally perform.

The Managerial Facet

The managerial facet can be considered as the last piece of the puzzle for this article, the result between the union of the socio-psychological facet and the mathematical one, obviously with an optimization for the managerial environment. The purpose of this paragraph is to discuss about the response, for what concerns instruments dedicated to support decisions, of the decision-makers in a real and frenetic environment, where tensions, limitations, and trade-offs are palpable. Before continuing with the discussion, it is mandatory to define that almost all the instruments that will be presented are purely based on the historically most used metrics or the monetary one, and that this is not the only existing perspective but rather the most accepted and evolved one.

For what concerns decision instruments in a managerial scenario it is possible to outline an almost infinite series of different classification types, but the most common is the temporal one. Consequently, decisions instruments can be divided in two macro categories: feedforward decision instruments, that intuitively contains all the decision instruments that tries to predict the future starting from the actual situation plus a series of assumptions on the future evolution of the surrounding environment, and feedback decision instruments, that is correlated with taking decisions based on the analysis of historical records of the environment (Wilson M. S. R., Chua F. W., 1993).

As regards the first category, or the feedforward decision instruments, it can be further divided in three more sub-categories or: present, short-term, and long-term decision making. In the first sub-category it is possible to find all the instruments connected with the planning of the current activities of a firm, generally in this category the predominant instruments are the cost allocation ones such as Activity-Based Costing (ABC), Full cost, absorption costing and so on that, as the name suggests, have the purpose to classify and categorize costs based on the originating sources (Zimmerman J. L., 2003; Kaplan R. S., Anderson S. R., 2007).

Moving towards the second sub-category of feedforward instruments it is possible to find all the instruments related with short terms decisions, where for short terms is intended a period smaller than a year. Here it is possible to outline two instruments that dominates this scenario or the Cost-Volume-Profit (CVP) analysis, that is generally connected with the operating plan's decisions with the purpose of reaching the desired profit objective, and the differential costs and revenue analysis, which purpose is to analyze and compare the gain for different courses of action.

Lastly, as regards the thirds sub-category, it contains all the managerial instruments related with long term decisions. For what concerns this topic it is usually possible to outline two kinds of decisions. Investment decisions, that are a particular type of long-run decisions where an initial monetary amount is invested in the first period with the hope of receiving a series of benefits in a second period (Arnold J., Turley S., 1996), instruments like Net Present Value (NPV), payback method, and Internal Return Rate (IRR) are among them. The second type of long run decisions are the quantitative policy decisions, that differ from the investments one as it is connected with a variation of

the policy or, a course or principle of action adopted, that change the rules that shapes the long-term environment of a particular firm.

While talking about these instruments it is mandatory to bear in mind the different trade-offs that are happening under the scenes. Beginning with present decision-making it is possible to find instruments with a high need for information as uncertainty (and in most of the cases also risk) can be neglected (this because the relative cost of a "piece" of information increase with the increase of uncertainty) leading to a faithful representation of the decision scenario. Moving towards short-run decision-making, and moreover towards the long-run one, with the rise of the levels as regards risk and uncertainty, the instruments used are less dependent from precise information, consequently leading to less precise solutions.

For what concerns the second typology of decision instruments, or the feedback ones, it is possible to outline two different ideologies on the most appropriate and effective way of measuring. The first ones, the monetary performance measurements, are connected with the past monetary performance of a firm. The second ones, referred to as non-monetary performance measurement/Key Performance Indicators (KPI), that, intuitively form the name, are mostly based upon non-monetary metrics.

For what concerns the differences between these two instruments it is possible to say that, as a consequence of their nature, non-monetary performance indicators results more connected with the effective strategy of the company, moreover they are also a better outliner of the cause effect relationship in the variations of the indicators, leading to better definition of the environment if correctly calibrated. On the other side monetary performance indicators are more easily comparable, uniform, and "ready to use" leaving less space for misinterpretation and decreasing the total needed time to apply them.

In conclusion, it is important to notice that also in the managerial scenario there is not only one correct instrument to use but rather a series of different possibilities that are strictly correlated with the starting problem environment and the defined goal.

Conclusions

In this article were defined three different, strictly interconnected and interrelated, facets that need to be taken into account while making a decision. The first facet, or the socio-psychological one, has shown the main human obstacles that act behind the lines of a decisional process both in a single decision-maker scenario and in a team one, defining the imperfections of the human nature and its connected instincts, behaviors, problems. The second facet shows how mathematics tries to solve the plethora of problems by proposing different models and theories, each one with a different level of "denaturation" from the reality. The last facet can be considered as the weighted mean between the first two facets, that results in a series of instruments tailored onto each peculiar managerial problem.

As said in the abstract, the purpose of this paragraph's categorization is to give a unified "third person" perspective about the problem environment. A good manager, that also wants to be a good decision-maker, must know his or her own irrational without forgetting the rational one before making a decision based upon certain managerial instruments.

Lastly, it is mandatory to remind that all the obstacles, instruments, categorizations discussed in this article are only a fraction of all the existing ones, and that an article like this can only scratch the surface of an extremely complex argument as the one discussed in these pages.

References

[1] Aldag Ramon J., Kuzuhara Loren W., Creating High Performance Teams: applied strategies and tools for managers and team members, Routledge, 2015.

[2] Arnold John, Turley Stuart, Accounting for Management Decisions: third edition, Prentice Hall Europe, 1996.

[3] Ball M. O., Magnanti T. L., Monma C.L., Nemhauser G.L., Network Routing: handbooks in operations research and management science, volume 8, Elsevier Sience B.V, 1995.

[4] Bell David E., Riaffa Howard, Tversky Amos, Decision Making: Descriptive, normative and prescriptive interactions, Cambridge University Press, 1988.

[5] Beyerlein Michael M., Jhonson Douglas A., Beyerlein Susan T., Advances in Interdisciplinary Studies of Work Teams: volume 3, team leadership, Jai Press Inc., 1996.

[6] Beyerlein Michael M., Jhonson Douglas A., Beyerlein Susan T., Advances in Interdisciplinary Studies of Work Teams: volume 7, team development, Elsevier Science Inc., 2000.

[7] Bhimani Alnoor, Horngren Charles T., Sundem Gary L., Stratton William O., Burgstahler David, Schatzberg Jeff, Introduction to Management Accounting, Pearson Education Limited, 2012.

[8] Bicchieri Cristina, Rationality and Coordination: Cambridge studies in probability induction, and decision theory, Cambridge University Press, 1993.

[9] Bisdorff Raymond, Dias Luis C., Meyer Patrick, Mousseau Vincent, Pirlot Marc, Evaluation and Decision Models with Multiple Criteria: case studies, Springer-Verlag, 2015.

[10] Borek Alexander, Parlikad Ajith, Webb Jela, Woodall Philip, Total Information Risk Management: maximizing the value of data and information assets, Elsevier Inc., 2014.

[11] Bouyssou Denis, Marchant Thierry, Pirlot Marc, Tsoukias Alexis, Vincke Philippe, Evaluation and Decision Models with Multiple Criteria: stepping stones for the analyst, Springer Science + Business Media Inc., 2006.

[12] Brandimarte Paolo, Quantitative Methods: an introduction for business management, John Wiley and Sons, Inc., 2011.

[13] Brown Rex, Rational Choice and Judgement: decision analysis for the decider, Wiley, 2005.

[14] Chapman Christopher S., Hopwood Anthony G., Shields Michael D., Handbook of Management Accounting Research: volume 2, Elsevier Ltd., 2007.

[15] Chen Wai-Kai, Theory of Nets: flows in networks, John Wiley & Sons, Inc., 1990.

[16] Chevallier Arnaud, Strategic Thinking in Complex Problem Solving, Oxford University Press, 2016.

[17] Clemen Robert T., Making Hard Decision: an introduction to decision analysis, Duxbury Press, 1996.

[18] Coombs Hugh, Hobbs David, Jenkins Ellis, Management Accounting: principles and applications, Sage Publications Ltd, 2005.

[19] Drummond Helga, Guide to Decision Making: getting it more right than wrong, The Economist Newspaper Ltd., 2012.

[20] Drury Colin, Costing, an Introduction: second edition, Chapman and Hall, 1990.

[21] Drury Colin, Management Accounting for Business: 6th edition, Cengage, 2016.

[22] Finlay Pauln N., Mathematical Modelling in Business Decision-Making, Croom Helm Ltd. 1985.

[23] Finley Michael, Robbins Harvey, Why Teams Don't Work: what went wrong and how to make it right, Peterson Education Center, 1995.

[24] Fortune Joyce, Peters Geoff, Learning from Failure: the systems approach, Wiley, 1995.

[25] Fox William P., Mathematical Modeling for Business Analytics, Taylor &Francis Group, LLC, 2018.

[26] Goicoechea A., Duckstein L., Zionts S., Multiple Criteria Decision Making: proceedings of the ninth international conference: theory and applications in business, industry, and government, Springer-Verlag, 1992.
[27] Goodwin Paul, Wright George, Decision Analysis for Management Judgement, Wiley, 2014.
[28] Goulb Andrew L., Decision Analysis: an integrated approach, John Wiley & Sons, Inc., 1997.
[29] Hart Paul T., Irving L. Janis' Victims of Groupthink, Political Psychology, Vol. 12, No. 2, 1991.
[30] Hensher David A., Rose John M., Greene William H., Applied Choice Analysis: second edition, Cambridge University Press, 2015.
[31] Hillard Robert, Information-Driven Business: how to manage data and information for maximum advantage, John Wiley and Sons, Inc., 2010.
[32] Hiller S. Fredrick, Lieberman Gerald J., Introduction to Operations Research, McGraw-Hill Inc., 1995.
[33] Hodgkinson Gerard P., Starbuck William H., The Oxford Handbook of Organizational Decision Making, Oxford University Press, 2008.
[34] Horngren Charles T., Datar Srikant M., Rajan Madhav V. Cost Accounting: a managerial emphasis, fourteenth edition, Pearsons Education Limited, 2012.
[35] Horowitz ira, Organization and Decision Theory, Kluwer Academic Publishers, 1990.
[36] Kaplan Robert S., Anderson Steven R., Time-Driven Activity-Based Costing: a simple and more powerful path to higher profits, Harvard Business School Publishing Corporation, 2007.
[37] Kaplan Robert S., Cooper Robin, Cost and Effect: using integrated cost systems to drive profitability and performance, Harvard Business School Press, 1998.
[38] Karni Edi, Decision Making Under Uncertainty, Harvard University Press, 1985.
[39] Katzenbach John R., Smith Douglas K., The Wisdom of Teams: creating the high-performance organization, McKinsey & Company Inc., 1993.
[40] Kayser Thomas A., Building Team Power: how to unleash the collaborative genius of team for increased engagement, productivity, and results, McGraw-Hill, 2011.
[41] Klein Gary, Source of Power: how people make decisions, The MIT Press, 1999.
[42] Knight James A., Value Based Management: developing a systematic approach to creating shareholder value, McGraw-Hill, 1998.
[43] Levi Daniel, Group Dynamics for Teams, Sage Publications Inc., 2001.
[44] Levi Daniel, Group Dynamics for Teams, Sage Publications, Inc., 2017.
[45] Lootsma Freerk A., Multi-Criteria Decision Analysis via Ratio and Difference Judgement, Kluwer Academic Publishers, 1999.
[46] Lucia Antoniette D., Lepsinger Richard, The Art and Science of 360° Feedback, Jossey-Bass Pfeiffer, 1997.
[47] March James G., Decisions and Organizations, Basil Blackwell Inc., 1988.
[48] Martin John D., Petty William J., Value Based Management: the corporate response to the shareholders revolution, Harvard Business School Press, 2000.
[49] Maskell Brian H., Making the Numbers Count: second edition, Taylor and Francis Group LLC, 2009.
[50] Merchant Kenneth A., Van Der Stede Wim A., Management Control Systems: performance measurement, evaluation and incentives, Prentice Hall, 2012.
[51] Moder Joseph J., Elmaghraby Salah E., Handbook of Operations Research: foundations and fundamentals, Litton Educational Publishing, Inc., 1978.
[52] Moder Joseph J., Elmaghraby Salah E., Handbook of Operations Research: models and applications, Litton Educational Publishing, Inc., 1978.
[53] Monahan George E., Management Decision Making, Cambridge University Press, 2000.
[54] Moore Don A., Bazerman Max H., Judgement in Managerial Decision Making: 7th edition, John Wiley & Sons, Inc., 2009.

[55] Rodin E. I., De Buryn Chr., Colson G., Models and Methods in Multiple Criteria Decision Making, Pergamon Press plc, 1989.
[56] Roman Daniel D., Managing Projects: a systems approach, Elsevier Science Publishing Co., Inc., 1986.
[57] Saaty Thomas L., Multicriteria Decision Making: the analytic hierarchy process: planning, priority settings, resource allocation, RWS Publications, 1990.
[58] Sengupta Jati K., Optimal Decisions under Uncertainty: methods, models and management, Springer-Verlag, 1985.
[59] Shapira Zur, Risk Taking: a managerial perspective, Russel Sage Foundation, 1995.
[60] Shwenk Charles R., The Essence of Strategic Decision Making, Lexington Books, 1988.
[61] Smith J.Q., Decision Analysis: a bayesian approach, Chapman and Hall Ltd., 1988.
[62] Srinivasan R., Strategic Business Decisions: a quantitative approach, Springer, 2014.
[63] Steering Committee on Space Applications and Commercialization, Space Studies Board, Division on Engineering and Physical Sciences and Studies Board, Division on Earth and Life Studies, National Research Council, Transforming Remote Sensing Data into Information and Applications, National Academy Press, 2001.
[64] Wagner Harvey M., Principles of Operations Research: with applications to managerial decisions, Prentice-Hall, Inc., 1969.
[65] Waters Donald, Quantitative Methods for Business: second edition, Addison Wesley Longman Publishers Ltd., 1997.
[66] Wilson Richard M.S., Chua Wai F., Managerial Accounting: method and meaning, Chapman & Hall, 1993.
[67] Wisniewski Mik, Quantitative Methods for Decision Makers, Pitman Publishing, 1994.
[68] Zimmerman Jerold L., Accounting for Decision Making and Control: fourth edition, McGraw-Hill companies, Inc., 2003.