



RESEARCH ARTICLE

POSSIBILITY THEORY FOR MANAGERIAL AND ECONOMIC DECISION-MAKING UNDER UNCERTAINTY

Dr. Jayesh Vijay Rao Karanjgaonkar

Department of Mathematics, Swami Atmanand Government English Medium Model College, Atari, Raipur, Chhattisgarh, India

ARTICLE INFO

Article History:

Received 18th June, 2026
Received in revised form
24th July, 2026
Accepted 26th August, 2026
Published online 30th September, 2026

Keywords:

Possibility Theory; Fuzzy Sets;
Managerial Decision-Making; Economic
Uncertainty; Decision Analysis

*Corresponding author:

Dr. Jayesh Vijay Rao Karanjgaonkar

ABSTRACT

Background: Managerial and economic decisions are routinely made under incomplete, vague, or ambiguous information that classical probability theory is not always well suited to represent, particularly when the uncertainty involved is epistemic or linguistic rather than purely a matter of chance. **Methods:** This is a conceptual review paper. It develops a taxonomy of uncertainty types relevant to managerial and economic decision-making, sets out the formal apparatus of possibility theory, and reviews methods for constructing possibility distributions, applying this apparatus to established managerial and economic decision problems drawn from the literature. **Results:** Only aleatory (chance-based) uncertainty is naturally suited to probabilistic treatment; epistemic, linguistic, model, completeness, value, recognition, and decision-related uncertainty are common in business practice but poorly served by forced probability estimates. Possibility theory, through crisp, fuzzy, and interval restrictions and six practical construction methods, applies directly to risk assessment, strategic planning, resource allocation, project scheduling, supplier selection, and negotiation, and to consumer behaviour, firm production decisions, macroeconomic forecasting, and investment decisions under Knightian uncertainty. **Conclusion:** Possibility theory merits a routine, taught place alongside probability theory in applied managerial and economic decision analysis, reserved specifically for uncertainty that is vague, judgement-based, and non-frequentist in character.

Copyright©2026, Jayesh Vijay Rao Karanjgaonkar. 2026. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Dr. Jayesh Vijay Rao Karanjgaonkar. 2026. "Possibility Theory for Managerial and Economic Decision-Making Under Uncertainty". *International Journal of Current Research*, 18, (09), 38208-38212.

INTRODUCTION

Every managerial and economic decision of consequence is made under some degree of incomplete knowledge. Vague verbal reports, sparse data, and genuinely one-off situations are common in business practice, yet the dominant formal response to uncertainty in management and economics remains probability theory, which assumes a well-defined reference class and additive, frequency-based odds¹. This assumption holds well for chance-driven processes, but it is strained by Knight's classical distinction between risk, where the odds are knowable, and uncertainty proper, where they are not². Forcing a manager's linguistic judgement — "demand is likely strong," "the supplier is fairly reliable" — into a single precise probability manufactures a false precision that the underlying information does not support. This paper argues that possibility theory, developed by Zadeh as a companion framework to fuzzy sets¹, deserves a more deliberate place in the applied toolkit of managers and economists for this class of vague, judgement-based, non-frequentist uncertainty, without displacing probability theory where it remains the appropriate tool. The paper (i) develops a taxonomy of uncertainty types

relevant to business decision-making; (ii) sets out the possibility measure, the necessity measure, and the possibility distribution, together with Zadeh's theory of possibilistic restrictions; (iii) reviews practical methods for constructing possibility distributions from the kind of information managers and economists actually have; and (iv) applies this apparatus to a sequence of managerial decisions — risk assessment, strategic planning, resource allocation, project scheduling, supplier selection, and negotiation — and to core business-economic decisions — consumer behaviour, firm production and cost decisions, and investment under genuine (Knightian) ambiguity — viewed throughout through the economic lens of the firm and its decision-makers rather than as abstract mathematics. The remainder of the paper is organised as a conceptual review: Materials and Methods describes the analytical approach; Results presents the taxonomy, the formal apparatus, and the applied analysis; and Discussion sets out the paper's position and its limitations.

MATERIALS AND METHODS

This is a conceptual, literature-based paper rather than an empirical study; no primary data were collected and no

statistical testing was performed. The analysis proceeded in three stages. First, a taxonomy of uncertainty types relevant to managerial and economic decision-making was constructed by drawing on established distinctions in decision theory and economics, most notably Knight's separation of measurable risk from genuine uncertainty², and by categorising the further sources of imprecision — linguistic vagueness, model choice, incomplete information, value conflict, misclassification, and downstream decision consequences — that recur in business practice. Second, the formal apparatus of possibility theory was assembled from its founding sources, principally Zadeh's original formulation of fuzzy sets and possibility theory^{3, 1}, and its systematic treatment by Dubois and Prade^{4, 9}, together with six recognised methods for constructing a possibility distribution from organisational information. Third, this apparatus was applied illustratively to managerial and economic decision problems selected for their recurrence in business practice and for prior treatment in the possibility-theory and decision-science literature, including foundational behavioural evidence on ambiguity aversion⁶ and Shackle's related economic concept of potential surprise^{7, 8}. The contribution is conceptual and integrative rather than empirical.

RESULTS

Taxonomy of uncertainty in managerial and economic decision-making: Eight distinct types of uncertainty recur in managerial and economic decision-making, and only the first is naturally suited to probabilistic treatment

- Aleatory uncertainty: irreducible randomness in a stable process (e.g., short-run sales fluctuations), well handled by probability.
- Epistemic uncertainty: a reducible lack of knowledge (e.g., incomplete market research) that more data or better models could shrink, but which is not itself a matter of chance.
- Linguistic uncertainty: vagueness in natural language (“high risk,” “significant growth”) that data collection cannot resolve because the ambiguity is in the description, not the world.
- Model uncertainty: doubt about which representation of a system is correct, distinct from doubt about a chosen model's parameters.
- Completeness uncertainty: awareness that available data is only a fraction of what exists, often without knowledge of the shape of what is missing.
- Value uncertainty: disagreement about the objectives or priorities that should govern a decision, rather than about facts.
- Recognition uncertainty: misclassification or misperception of a signal, such as mistaking a competitor's tactical move for a strategic one.
- Decision-related uncertainty: uncertainty about the consequences of a chosen course of action, typically compounding several of the types above.

Distinguishing these types matters because it determines which formal tool is appropriate: probability theory for aleatory uncertainty, and — this paper argues — possibility theory for the epistemic, linguistic, model, and completeness uncertainty that is pervasive in business practice but poorly served by a manufactured probability number.

Possibility theory: formal foundations: Possibility theory was introduced by Zadeh¹ as a formal extension of fuzzy set theory³. Where probability quantifies frequency or likelihood, possibility quantifies plausibility or feasibility given the information at hand, independent of any frequency claim.

A possibility measure Π assigns each event A a value in $[0,1]$, where $\Pi(A)=0$ means A is impossible and $\Pi(A)=1$ means A is fully consistent with what is known. Its defining axiom is maxitivity, $\Pi(A \cup B) = \max(\Pi(A), \Pi(B))$, replacing probability's additivity axiom. A dual necessity measure N , with $N(A) = 1 - \Pi(\neg A)$ ⁴, captures the degree to which an event is certain rather than merely consistent with the evidence, giving the framework two distinct handles — plausibility and certainty — that collapse into a single number under probability. The possibility measure is generated from a possibility distribution $\pi(x)$, normalised so that its supremum over x equals 1, with $\Pi(A)$ recovered as the supremum of $\pi(x)$ over x in A . Where a fuzzy set A has membership function $\mu_a(x)$, that function can be read directly as a possibility distribution, $\pi(x) = \mu_a(x)$, giving possibility theory direct access to the existing toolkit of fuzzy operations⁵.

Three properties distinguish possibility from probability: possibility is maxitive rather than additive; possibility need not sum to one across a complementary pair, since $\Pi(A) + \Pi(\neg A)$ can be less than or equal to 1, allowing an event and its negation to be simultaneously fully possible; and this lets possibility theory represent genuine ignorance as ignorance rather than converting it into an arbitrary probability split such as 0.5/0.5.

Possibilistic restrictions: Zadeh's fuller theory treats a proposition about a variable X as inducing a restriction on the values X may take, written X is $r(p)$, where $r(p)$ is the possibility distribution induced by proposition p ¹. Three restriction types recur in business use: crisp restrictions (“ $X = a$ ”), where only the stated value is possible, suited to exact figures such as a contractually fixed price; fuzzy restrictions (“delivery time is short,” “satisfaction is high”), where $\pi(x)$ equals the membership function of the corresponding vague category, letting managers encode linguistic judgements directly; and interval restrictions (“ X is between a and b ,” possibly softened at the edges), which assign full possibility across a range and none outside it, suited to estimates given only as a bound.

Restrictions combine through three operations: conjunction, $\pi(x) = \min(\mu_a(x), \mu^b(x))$, for “ X is A and B ”; disjunction, $\pi(x) = \max(\mu_a(x), \mu^b(x))$, for “ X is A or B ”; and projection, obtained by taking the supremum over a second variable of a joint distribution, for deriving a single-variable restriction from a joint one. These three operations are sufficient to build arbitrarily complex combined restrictions — for example, a supplier who must be simultaneously “low cost” and “high quality,” or an investment that is plausible under either of two market scenarios — out of the basic crisp, fuzzy, and interval building blocks.

Constructing possibility distributions

Six practical methods allow a possibility distribution to be built from the kind of information managers and economists actually have on hand.

- From an existing fuzzy set: adopting an already-defined membership function (e.g., an organisation's "preferred vendor" category) directly as $\pi(x)$.
- From expert elicitation: asking domain experts to rate the plausibility of different values and normalising so the most plausible value receives possibility 1.
- From a probability distribution: transforming a known probability density or cumulative distribution into a possibility distribution, so that anything with non-trivial probability also receives high possibility.
- From interval data: assigning full possibility across a stated bound and none outside it, when only a range, not a point estimate, is genuinely known.
- From relative ranking: assigning possibility values by ordinal rank when a decision-maker can order alternatives but would not defend a cardinal number for any of them.
- From maximum entropy: selecting, subject to known constraints, the distribution that is maximally non-committal, avoiding unjustified extra information⁵.

The choice among these methods should match the actual information condition at hand — an existing category or elicited judgement where available, a probability transform where frequency data exists, an interval where only a bound is known, a ranking where only an order is known, and maximum entropy where firm constraints justify the added rigour. Whichever method is used, the resulting distribution should be normalised, its construction documented, and its sensitivity to the underlying assumptions checked before it is used to support a consequential decision.

Applications in managerial decision-making

Six recurring managerial decisions illustrate how possibility theory applies in practice.

- Risk assessment: demand scenarios ("high," "moderate," "low") are defined as fuzzy sets from expert judgement, producing a possibility distribution over outcomes without requiring point probabilities the decision-maker does not actually have; the necessity measure gives a conservative estimate of how unavoidable a specific downside outcome is.
- Strategic planning: candidate future scenarios receive possibility distributions reflecting current signals, and strategies are evaluated for robustness across the plausible range rather than against a single point forecast — a possibilistic formalisation of planning for resilience.
- Resource allocation: project merit against fuzzy criteria ("high strategic value," "moderate risk") is expressed as possibility distributions, and budget is allocated to maximise the overall possibility of meeting organisational goals subject to fuzzy constraints such as "approximately twenty percent of the budget."
- Project scheduling: task durations expressed as fuzzy intervals ("five to seven days") are propagated through the project network to yield a possibilistic estimate of completion time, extending the Program Evaluation and Review Technique (PERT) to imprecise duration estimates.
- Supplier selection: qualitative ratings on criteria such as reliability and reputation are converted into possibility distributions and combined through a possibilistic multi-criteria method, avoiding a spuriously precise numerical score for judgements that were only ever qualitative.

- Negotiation: each party's acceptable range for price, delivery time, or contract length is represented as a fuzzy interval, and the possibility of agreement is assessed from the overlap between the two ranges, giving negotiators a formal handle on compromise-seeking.

Because significant business decisions typically compound several of these problems at once — a market-entry decision, for example, draws simultaneously on risk assessment, strategic planning, resource allocation, and supplier selection — the conjunction operator described above provides the means of combining their separate possibility distributions into a single overall assessment of the decision as a whole. Read together, these applications recast managerial decision-making as a sequence of possibility distribution problems grounded in the economics of the firm — allocating scarce resources, pricing risk, and structuring contracts — rather than as an exercise in manufactured point probabilities.

Applications in economic decision-making

Four applications extend the same apparatus to core business-economics decisions.

- Consumer behaviour: preferences expressed in vague terms ("relatively inexpensive," "high quality") are represented as fuzzy sets, and purchase decisions are modelled as maximising the possibility of meeting stated aspiration levels rather than an assumed but unobserved precise utility function.
- Firm production and cost decisions: uncertain demand, input prices, and technological change are described as fuzzy sets ("high demand," "significant cost increase") feeding into production functions with fuzzy parameters, so that production levels are chosen to maximise the possibility of meeting profit or cost targets across a band of plausible futures rather than a single-point forecast.
- Macroeconomic forecasting relevant to business planning: variables such as inflation or growth are typically discussed by forecasters in fuzzy linguistic terms ("high inflation," "stable growth") before, if ever, being pinned down numerically; representing these judgements directly as possibility distributions produces a forecast expressed as a range of plausible outcomes for business planning purposes.
- Investment and financial decision-making under Knightian uncertainty: the distinction between measurable risk and genuine, unmeasurable uncertainty² is sharpest in investment decisions, where possibility and necessity can be assessed separately — a market correction may be highly possible while remaining far from certain — avoiding the false precision of a single subjective probability. Ellsberg's demonstration that decision-makers systematically prefer known probabilities to ambiguous ones⁶, and Shackle's related notion of potential surprise^{7, 8}, both anticipate this need for a plausibility-based, rather than purely frequency-based, treatment of genuinely ambiguous business decisions.

Formally, a possibility distribution $\pi(x)$ over an economic variable such as profit or return allows a decision rule that maximises utility weighted by possibility, $U(x) \cdot \pi(x)$, or that uses the necessity measure to guarantee a minimum acceptable outcome — an approach particularly suited to entrepreneurial

and investment decisions where the relevant probabilities are not so much unknown as genuinely undefined. Dubois and Prade's systematic treatment of possibility theory^{4, 9} remains the principal technical reference for extending this apparatus rigorously to further economic settings.

DISCUSSION

Possibility theory should be understood not as a rival to probability theory but as a complementary formalism suited to a specific, common cluster of business uncertainty: epistemic rather than aleatory, linguistic rather than numeric, judgement-driven rather than frequency-derived, and genuinely ambiguous in Knight's sense² rather than merely risky. Wherever a decision genuinely rests on repeatable, well-sampled randomness, probability theory remains the right tool. But wherever a manager or economist is working from vague verbal reports, sparse or conflicting expert opinion, or a one-off situation with no meaningful reference class, possibility theory represents the actual state of knowledge — including its gaps — more honestly than a manufactured probability number does.

Two objections deserve a direct answer. First, possibility distributions are themselves subjective, resting on elicited expert judgement or an analyst's chosen fuzzy set definitions. This is true, but it is not a point of disanalogy with the alternative: the subjective probability estimates that fill in for missing frequency data in most applied business forecasting are no less a matter of judgement, and possibility theory has the advantage of not dressing that judgement in an axiomatic structure that implies more precision than the underlying judgement possesses. Second, possibility theory lacks probability theory's aggregation machinery for combining independent estimates across many agents or events; this is a genuine current limitation rather than a fixable misunderstanding, and it is the strongest reason possibility theory remains a complement to, rather than a substitute for, probability theory.

Four further limitations qualify the position argued here. Construction of fuzzy sets and elicitation of possibility values are inescapably shaped by the analyst's or expert's framing. Results obtained from a possibility distribution and from a probability distribution are not directly commensurable, complicating any attempt to combine or communicate them together. Possibilistic methods in business and economics remain comparatively immature in standardisation and software tooling relative to over a century of probabilistic and statistical development.

And because possibility theory represents a genuinely different way of thinking about uncertainty than the probabilistic training most managers and economists receive, securing buy-in for a possibilistic analysis alongside a conventional probabilistic one remains, in practice, an uphill argument. None of these limitations undermines the case for the applications set out in the Results: a wide range of consequential business decisions can be reformulated as possibility distribution problems using construction methods already well suited to the vague, expert-judgement-laden, and data-scarce information managers and economists actually have.

CONCLUSION

Managerial and economic decisions are made under several formally distinct types of uncertainty, and only aleatory uncertainty is naturally and comfortably represented by probability theory. Possibility theory, built on the possibility measure, necessity measure, and possibility distribution, together with Zadeh's theory of possibilistic restrictions, offers a formal alternative purpose-built for the epistemic, linguistic, and model-based uncertainty pervasive in business practice.

The managerial and economic applications reviewed here — from risk assessment and strategic planning to consumer behaviour and investment decisions under Knightian uncertainty — show that a wide range of real business decisions can be reformulated as possibility distribution problems. Possibility theory merits a routine, taught place beside probability theory in applied managerial and economic decision analysis, reserved specifically for the uncertainty that probability theory was never really built to represent.

Acknowledgement: None.

Conflict of Interest Statement: The author declares no conflict of interest.

Funding Statement: This research received no specific grant or financial support from any funding agency in the public, commercial, or not-for-profit sectors. [Please confirm or amend before submission.]

Key Points

- Possibility theory offers a formal, complementary alternative to probability theory for the epistemic, linguistic, and model-based uncertainty pervasive in managerial and economic decisions.
- A taxonomy distinguishing aleatory uncertainty from seven further uncertainty types helps decision-makers choose the right formal tool rather than defaulting to probability.
- Zadeh's possibilistic restrictions (crisp, fuzzy, interval) and six practical construction methods make possibility distributions usable with the vague, expert-judgement-based information managers and economists actually have.
- The framework applies directly to risk assessment, strategic planning, resource allocation, supplier selection, consumer behaviour modelling, and investment decisions under Knightian uncertainty.
- Wider adoption requires addressing possibility theory's subjectivity, limited standardisation, and comparability challenges relative to probability theory.

Glossary of Abbreviations

Π — possibility measure

N — necessity measure

$\pi(x)$ — possibility distribution

PERT — Program Evaluation and Review Technique

REFERENCES

1. Zadeh, LA. 1978. Fuzzy sets as a basis for a theory of possibility. *Fuzzy Sets Syst.*, 1:3-28.

2. Knight, FH. 1921. Risk, Uncertainty and Profit. Boston: Houghton Mifflin.
3. Zadeh, LA. 1965. Fuzzy sets. Inform. Control, 8:338-353.
4. Dubois, D., Prade, H. 1988. Possibility Theory: An Approach to Computerized Processing of Uncertainty. New York: Plenum Press.
5. Klir, GJ., Yuan, B. 1995. Fuzzy Sets and Fuzzy Logic: Theory and Applications. Upper Saddle River (NJ): Prentice Hall.
6. Ellsberg, D. 1961. Risk, ambiguity, and the Savage axioms. Q. J. Econ., 75:643-669.
7. Shackle, GLS. 1949. Expectation in Economics. Cambridge: Cambridge University Press.
8. Shackle, GLS. 1961. Decision, Order and Time in Human Affairs. Cambridge: Cambridge University Press.
9. Dubois, D., Prade, H. 2001. Possibility theory, probability theory and multiple-valued logics: a clarification. Ann. Math. Artif. Intell., 32:35-66.
