

A Conceptual Model of Participation Utility Under Uncertainty in Interactive Systems

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Abstract—This letter proposes a formalized conceptual model of participation utility in interactive systems operating under uncertainty. I define participation utility as the aggregation of short-term and long-term participation intention, structured by seven abstract factors: outcome payoff, total cost, temporal commitment, extrinsic motivation, intrinsic motivation, failure cost, and risk. Rather than optimizing predictive accuracy or fitting empirical data, this work aims to identify a complete, non-overlapping factor space that explains why participants choose to engage, persist, or withdraw under uncertain conditions. The model is intended as a theoretical foundation for future empirical validation, system diagnosis, and design analysis.

I. PARTICIPATION INTENTION MODEL

I define participation utility U as the combined effect of short-term and long-term participation intention:

$$U = P_{\text{short}} + P_{\text{long}} \quad (1)$$

Short-term participation intention reflects the immediate willingness to engage with an activity or system. It is primarily influenced by perceived payoff and motivational states at the moment of decision:

$$P_{\text{short}} = f(O, M_e, M_i) \quad (2)$$

where f is generally assumed to be monotonically increasing with respect to all its arguments.

Long-term participation intention reflects the willingness to persist over time under uncertainty, accumulated pressure, and potential loss. It incorporates both motivational and structural constraints:

$$P_{\text{long}} = g(O, C, T, F, R, M_e, M_i) \quad (3)$$

The specific functional forms of $f(\cdot)$ and $g(\cdot)$ are intentionally left unspecified to maintain conceptual generality. This work focuses on identifying and structuring the factor space rather than committing to a particular optimization or weighting scheme. However, in most interactive contexts, O, M_e, M_i serve as driving forces, while C, T, F, R act as inhibitory pressures or costs.

A. Outcome Payoff

Outcome payoff O represents the perceived value associated with successful participation:

$$O = \{O_d, O_x, O_s\} \quad (4)$$

where O_d denotes direct payoff, O_x denotes exclusivity or scarcity-based payoff, and O_s denotes social payoff derived from recognition or shared meaning.

B. Total Cost

Total cost C represents all forms of expenditure required prior to or during participation, independent of outcome:

$$C = \{C_c, C_p, C_t, C_w, C_o\} \quad (5)$$

where C_c is cognitive cost, C_p is practice or skill acquisition cost, C_t is total time cost, C_w is waiting cost, and C_o is opportunity cost.

C. Temporal Commitment

Temporal commitment T describes how participation pressure is distributed and accumulated over time:

$$T = \{T_s, T_w, T_f, T_h\} \quad (6)$$

where T_s denotes single-session duration, T_w denotes the proportion of waiting time, T_f denotes participation frequency, and T_h denotes the total time horizon required to reach a meaningful outcome.

D. Extrinsic Motivation

Extrinsic motivation M_e represents externally induced drivers:

$$M_e = \{M_{e,s}, M_{e,v}, M_{e,p}, M_{e,st}\} \quad (7)$$

where components correspond to social, value-based, pressure-based, and stability-based motivation.

E. Intrinsic Motivation

Intrinsic motivation M_i follows established self-determination theory:

$$M_i = \{M_{i,a}, M_{i,m}, M_{i,p}, M_{i,r}\} \quad (8)$$

corresponding to autonomy, mastery, purpose, and relatedness.

F. Failure Cost

Failure cost F represents the additional loss incurred specifically upon unsuccessful participation:

$$F = \{F_s, F_o, F_a, F_r\} \quad (9)$$

where F_s is social cost, F_o is future exclusion cost, F_a is attribution cost, and F_r is recovery cost.

G. Risk

Risk R captures uncertainty beyond individual failure:

$$R = \{R_p, R_a, R_d\} \quad (10)$$

where R_p is predictability, R_a is acceptability of loss, and R_d is dependency risk.

REFERENCES

- [1] R. M. Ryan and E. L. Deci, "Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being," *American Psychologist*, vol. 55, no. 1, pp. 68–78, 2000. DOI: 10.1037/0003-066X.55.1.68.