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Do institutional designs matter for planning review? A garbage-can simulation approach

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ABSTRACT

The fact that institutional design coordinates decisions are not a new idea, but the study of its effectiveness under different settings is still unrevealed. In this paper, inspired by the garbage-can model, we conduct a set of computer simulations of collective decision making based on urban land use planning and design review process. The simulation results show that institutional designs matter in affecting organizational performance, and that different distributions of case intricacies result in different outcomes of the collective decision making for planning review.

KEYWORDS

- Self-organization
- institutional design
- planning review
- sequential decision making

Highlights

- The study explores the effects of institutional design on planning review decisions.
- We conduct computer simulations of collective decision through the garbage-can model.
- The results show that institutional design matters in affecting organizational performance

1. Introduction

Cities are the self-organizing outcomes of interdependent decisions regarding activities and construction (Portugali, 2000). Plans are needed for taming urban development (Lai, 2018). However, traditionally plans focus on investment in spatial design and regulations of institutional design (Hopkins, 2001). Evidence shows, however, that institutional designs are no less important than spatial designs (Alexander, 2005; Bolan, 1991; Lai, 2006). In other words, institutional designs are important in planning, but largely ignored because traditionally the field focuses more on spatial designs. On the other hand, previous work on institutional design for cities focuses either on structural constraints or on procedural constraints (e.g. Black, 1958; Lai, 1998). For example, Guler (2007) looked at the historical data of the venture capital firms in the U.S. to examine how institutional designs affected the effectiveness of sequential decision making in a multilevel context. Structural constraints delineate rights in participation, while procedural constraints codify how decision processes should be proceeded. Focused on multi-stage optimization under uncertainty, Varakantham (2016) explored how to use urban resources efficiently through sequential decision making. Here we focus on procedural constraints of institutional design in the context of planning review.

Institutional designs, structural or procedural, coordinate decisions made in interactive processes. Coordinating decisions connotes arranging decisions in space and time so that the outcome of such an arrangement yields an acceptable level of satisfaction. The decisions are interdependent and can be made by the same decision maker in arranging his or her activities or by other decision makers in building consensuses. The garbage-can model is adopted here and modified for simulating planning review processes (Cohen, March, & Olsen, 1972). There can be four modes of coordinating decisions: planning, administering, regulating, and governing (Lai, 2021~~19~~ **[Q1]**). A plan is a path in a decision tree that takes into account possible alternatives and uncertain outcomes and can be analysed through the decision analysis framework. Effective administration depends on useful organizational designs in that organizations are manifestations of decision coordination. Plans and organizations thus complement each other. Regulations identify permissible rights for the decision-maker to act. Governance implies collective choices. Managing urban complexity requires all four modes of decision coordination, that is, planning, administering, regulating, and governing, or PARGing. In particular, plans coordinate decisions through information; administration coordinates decisions through authorities in organizations; regulations coordinate decisions through rights; and governance coordinates decisions through collective choices, all bringing about order in the background of urban complexity. In terms of purposes, plans tend to cope with the problems of dynamics failure; administration deals with the problems of government failure; regulations cope with the problems of market failure in relation to externalities; and governance deals with the problems of market failure in relation to collective goods. It is regulated, constrained behaviour, or institutions, that we are mainly interested in this paper.

Simply put, institutions are the rules of the game, formal (e.g. regulations) or informal (e.g. culture) in society (North, 1990). They can be the rules about social choices (Arrow, 1970) or those about committee decisions (Black, 1958). They can be either spontaneously emergent (Lai, Han, & Ko, 2013) or purposefully designed (Alexander, 2017). Regardless, they are constraints on human behaviour and ways of coordinating decisions in order to attain order out of chaos. However, most of the previous work on institutional design focuses on theoretic construction-based, say, on transaction cost theory (e.g. Alexander, 2006) and empirical observation on, say, agenda setting in the public sector (Kingdon, 2003). In this paper, we attempt to explore the effects of institutional design in an organizational context of planning review through computer simulations.

The model of the administrative choice we used in the computer simulations is inspired by the garbage can model (Cohen et al., 1972) and the context in which the model is conceived is planning review for urban development. That said, the simulations modify the garbage can model to simulate the process of urban land use planning and design review in that there are three levels of sequential decision making each of which represents a hierarchical review process that takes into account degrees and distributions of case intricacy, quality of solutions and reviewer lenience. Specifically speaking, the computer simulations run 4800 rounds in which 50 cases are generated for each round choosing from six scenarios of review lenience ranging from 0.0 (strict) to 1.0 (tolerant), eight shapes for randomizing case intricacies ranging from −1.0 (most difficult) to 0.0 (most simple) and three solution quality levels of 0.5 (ordinary), 0.7 (good) and 0.9 (excellent). The results would provide insights into how the interactive process of the planning review committee works in order to explore the hidden properties the institutional design implies.

The rest of this paper is organized as follows. Section 2 explains some planning and design review processes to motivate the simulation design that is depicted in Section 3. Section 4 presents the simulation results. Section 5 provides some relevant discussion. Section 6 concludes.

2. Urban land use planning and design review process

At the theoretical level, the planning review process for urban land use planning and design is a manifestation of organizational choice behaviour which can be characterized, at least partially, by problematic preferences, fluid participants and unclear technologic and thus a garbage-can decision process. In particular, the planning issues are usually complex and wicked (Rittel & Webber, 1973) which would render the reviewers' preferences and available technology as ambiguous. The reviewers usually have limited terms who come and go in the review process, which makes the participation fluid. This garbage-can decision process can be seen as a sequential, complex structure that self-organizes itself with certain structural constraints as institutions (Lai, 1998; 2006; 2021).

The multistage process, which can be either sequential or parallel, is commonly adopted in urban land use and design review (Carmona, 2019). The result of each stage can be approval, re-submission or rejection, which is decided by staff or a commission using a simple or two-thirds majority rule. A commission can be composed of members from various backgrounds with different expertise, knowledge, and values. Furthermore, a commission may have several sub-commissions to deal with some specific issues and make suggestions to the commission meeting.

Pittsburgh (2016) requests all the development projects go through a design review, which is processed in the Department of City Planning. All design reviews start at the staff level, which will set the Urban Design Targets, drawing from the neighbourhood context, relevant master plans, and design guidelines, for guiding the project throughout the whole design review process. In some cases, if a project meets some or all of the Urban Design Targets, it may be approved in the initial stage without going through further design reviews. Otherwise, there are two possible paths: (1) It may be asked to revise the original proposal, re-submit, and be reviewed by the staff again, (2) it may be reviewed by the Contextual Design Advisory Panel (CDAP). The CDAP is a multi-disciplinary team of eight members with expertise, including architects, landscape architects, construction and materials specialists, and others. Occasionally, the CDAP may suggest workshops prior to the standard review meeting for resolving unusual or complicated design issues. Some projects are also required to be approved by the Planning Commission after the CDAP meeting. All other Zoning Code requirements will have to be met prior to the issuance of zoning approval for a project.

New York City (NYC, 2019) requests a land development application to be sequentially reviewed by the staff in the department of city planning, community board, borough board, city planning commission, city council, and the mayor. Prior to the start of the formal public review, two parallel reviews, namely a land-use review and an environmental review, have to be done first. The city planning commission, composed of seven members selected by the mayor and six others named by the borough presidents and public advocates with various backgrounds. In most cases, a simple majority rule applies; however, in some special cases, a supermajority of nine out of 13 commissioners is necessary. The city council will ask the land use subcommittee (landmarks, planning or zoning) to discuss the application and make a suggestion to the full land-use committee, then the entire council votes for making a decision. The mayor can veto the decision the city council made. However, the city council still gets the final decision to override the veto by a two-thirds majority vote (CPNYC, 2019).

Design Council (2013) in England suggests principles of design review, which is recognized in the National Planning Policy Framework, UK, for improving the quality of the built environment. Design review is processed by a panel of experts to help planning authorities for assessing projects submitted to them by developers. The design review panel also helps design teams on behalf of developers to communicate with planning authorities, community groups, and other independent panels, such as transportation, housing, heritage, environment, etc. There are three levels of design review panels: local, regional, and national. Depending on the type and size of a project, an appropriate design review panel will be in charge. The review of a project by more than one design review panel should be avoided for reducing time, confusion and potentially conflicting advice. Furthermore, Carmona (2018) found that a sequence of consistent design reviews at key stages to guide the planning process was widely expected by design teams. Although the review institution is differently implemented in each city, there are some common characteristics that can be extracted and generalized to construct simulations designed below for exploring some essential but hidden properties. For example, in Taipei city, the urban design committee reviews the projects based on a set of criteria on urban design targets and principles, including public space, urban design, pedestrian districts, etc. These review processes can be complex with the projects revised and resubmitted several times. Some illustrative examples of these processes created in light of the simulations presented here are given in Appendix C and explained in Section 3.2.

3. Simulation design

3.1. System structure

In the computer simulations, there can be two types of review or decision process: sequential and parallel. In the sequential review process in which the focus is on the allocation of authorities among different layers of administration, there are three levels of consecutive review meetings sequentially organized and the chairperson and members of each meeting are different. In the parallel review process in which the focus is on aggregation of experts' knowledge, there is only one level of review meeting and each member of the meeting is treated equally. To simplify, we focus on the sequential scenarios, setting aside the parallel ones for future work.

In the sequential review process, all the cases have to go to the first meeting for review and depending on whether the cases would be approved in the first, initial meeting, with some cases having to go to the remaining two review meetings. Simple cases can be decided in the first meeting, while ordinary and important cases have to be sent to the second and final meetings for consideration, respectively. There are three kinds of solutions: ordinary, good, and excellent, depending on whether the solutions would solve the problems associated with the cases. Since solutions will be improved based on the feedbacks from the associated meetings or workshops, each case has a corresponding solution in relation to the intricacy of the case. However, the correspondence between solutions and cases is randomly perturbed. There are three possible outcomes for a case under review at a meeting: approval, re-submission, and rejection.

According to the simulation process depicted above, there are six scenarios in the computer simulations classified by review lenience as follows:

- Scenario 1: Increasing leniencies from the initial to final review. It is to simulate a situation within an organization that the staff in the first review will carefully examine the application cases, give advises to the applicants, and reject inappropriate ones, while the second and final committees only check if the initial review complies the legal process or if the case is in conflict with other projects in a wider consideration.
- Scenario 2: Decreasing leniencies from the initial to final review. This situation may happen among hierarchically structures organizations when the responsibilities with different authority powers of three review committees are overlapped, intertwined or exceeded, that is, the higher review committee does not trust the decisions done by the lower committee, or the higher committee thinks they have the power to review the case from scratch. As a result, the lower committee may relax its review standard and just forward some questionable cases to the higher committee, and the higher committee becomes stricter.
- Scenario 3: Special committee review with the same but lowest review lenience at 0.3. For example, a development project may have to go through three independent review committees of environmental assessment, land use zoning adjustment, and financial feasibility evaluation sequentially. These review committees are composed of experts from different fields and focus on different interests. The degrees of leniencies in Scenarios 3, 4, 5, and 6 are increasing from 0.3 to 0.9 for comparing the effects of leniencies on the approval rates by the sequential committees.
- Scenario 4: Special committee review with the same review lenience at 0.5.
- Scenario 5: Special committee review with the same review lenience at 0.7.
- Scenario 6: Special committee review with the same review lenience at 0.9.

For each of the six scenarios, there are up to 50 cases generated randomly for 100 rounds. In order to simulate most, if not all, possible intricacies of the cases, for each scenario we adopt 8 shapes, namely M, V, Bell, Down, Up, Even, Reversed L, and L, of probability distribution to generate intricacy levels for all the cases (see Appendix B). Therefore, there are totally 100 × 8 × 6 = 4800 rounds for all the 6 scenarios. The controlled parameters of the simulation design are explained below and summarized in Table 1. The pseudo codes of the general algorithm for the simulations are depicted in the Appendix A. For each scenario the parameters in the general algorithm have to be adjusted according to Table 1.

Table 1. Review leniencies in the six scenarios.

Meeting\scenario	1	2	3	4	5	6
Initial	0.7	0.9	0.3	0.5	0.7	0.9
Second	0.8	0.8	0.3	0.5	0.7	0.9
Final	0.9	0.7	0.3	0.5	0.7	0.9

Case intricacy represents the level of intricacy of problems contained in a case to be reviewed and ranges from −1.0 (most difficult) to 0.0 (most simple). For illustration purpose, we may take cases with intricacy equal to or greater than −0.4 as simple ones, cases with intricacy between −0.4 and −0.8 as ordinary ones, and others as difficult ones. Solution quality specifies the effectiveness of alternatives that help solve the problems in a case and is set to three levels, 0.5 (ordinary), 0.7 (good) and 0.9 (excellent). Review lenience denotes the judgment of reviewers ranging from 0.0 (strict) to 1.0 (tolerant). In other words, a reviewer with lenience 0.0 is very picky and expects a perfect solution; on the other hand, a reviewer with lenience 1.0 is very kind, tolerates mistakes and passes solutions with some suggestions instead of requirements. Pass threshold means the level of score that the summed score across case intricacy, solution quality and review lenience of a case must pass in order to be approved. For example, if the case intricacy is −0.9, the solution quality is 0.5, and the review lenience is 0.7, the overall score is equal to 0.3. The case would not be approved even if the pass threshold is a lower one at 0.6. All the six scenarios are sequential decision processes. The number of simulation rounds is 100 for each of the six scenarios with the number of cases up to 50 for each simulation round, subject to random fluctuations. The pass thresholds are set to 0.8 and 0.6. If the score of a case is equal to or greater than 0.8, the case will be approved and sent to the next stage of review if necessary. If the score of a case is less than 0.8 but equal to or larger than 0.6, the case should be revised and resubmitted again. If the score of a case is less than 0.6, the case will be rejected. The differential levels of review lenience by reviewers are given in Table 1. Note that all simulation rounds are conducted based on the eight probability distribution shapes mentioned above for case intricacy, which are explained in Appendix B. Furthermore, to simulate the uncertainty, instability, or inconsistency in the review processes, the values of solution quality and review lenience are randomly adjusted by a range of ±10% for each round.

3.2. Illustrative examples

For better understanding the mechanism of the simulation, some illustrative examples are shown in Appendix C. In Scenario 1, probability distribution shape M, and round 1, there are five cases whose intricacies (Xi) decrease gradually from −0.6 (ordinary) to −1.0 (difficult). As shown in Table 1, leniencies (Li) of initial, second and final committee meetings are 0.7, 0.8 and 0.9, respectively. In case 1, although its problem is ordinary, X1 = 0.6, its solution (S11 = 0.4) is poor. Thus, its merit (R111 = 0.5) results in rejection. In case 2, its intricacy is −0.7. After re-submission, the quality of its solution is improved from 0.7 to 0.8 so that case 2 is forwarded to the second committee meeting, and approved by the final committee. The intricacy of case 3 is −0.8. After two re-submissions, the qualities of its solutions are improved from 0.7 to 0.9, and approved in the final committee. Case 4 successfully solves a very difficult problem (X4 = −0.9) after two improvements. Case 5 encounters an even difficult problem (X5 = −1.0). Although it does its best to propose a best solution (S51 = 1.0), the committee is not satisfied, and only gives its leniency (L1) of 0.7. Since there is no way to improve the solution, case 5 is rejected.

For comparison, the five cases with the same Xi and Sik are also illustrated in Scenario 2. The leniencies of Scenario 2, which are 0.9, 0.8 and 0.7, have a reversed order compared to those of Scenario 1. In other words, the three committees in Scenario 1 have from rigid to tolerate attitudes, while those in Scenario 2 are reversed. In Scenario 1, case 1 was rejected by the initial committee. But case 1 is approved by the final committee, since it has more chances to improve its solutions. Cases 2, 3, and 4 are approved in two Scenarios but experiencing different review processes. Case 5 is immediately rejected in Scenario 1. It cannot avoid the fate of rejection although it has passed the initial and second committees. After finishing each round, the ratios of rejection, re-submission and approval are calculated. From these illustrative examples, different institution designs do result in different outcomes.

4. Results

Figures 1–6 show a sample of the simulation results for the six scenarios with a particular probability distribution of the M shape (see Appendix B). The X-axis represents the 100 times of simulation rounds, while the Y-axis respectively represents the rates of approval, resubmission, and rejection of each simulation round. Table 2 shows the average approval, re-submission, and rejection rates for the probability distribution of the M shape. There are totally eight shapes of such probability distributions of case intricacies and we show here only the results of the M shape. On the face of it, all scenarios show a stable pattern of the proportional fluctuations of the three consecutive meeting outcomes over the 100 simulation rounds each of which contains up to 50 cases, showing a stable pattern of self-organization. The rates of approval, re-submission and rejection varied for all the six scenarios with Scenario 3 performed quite distinctly due to the lowest lenience (see Table 2).

Figure 1. Simulation results for Scenario 1 for the M shape probability distribution.

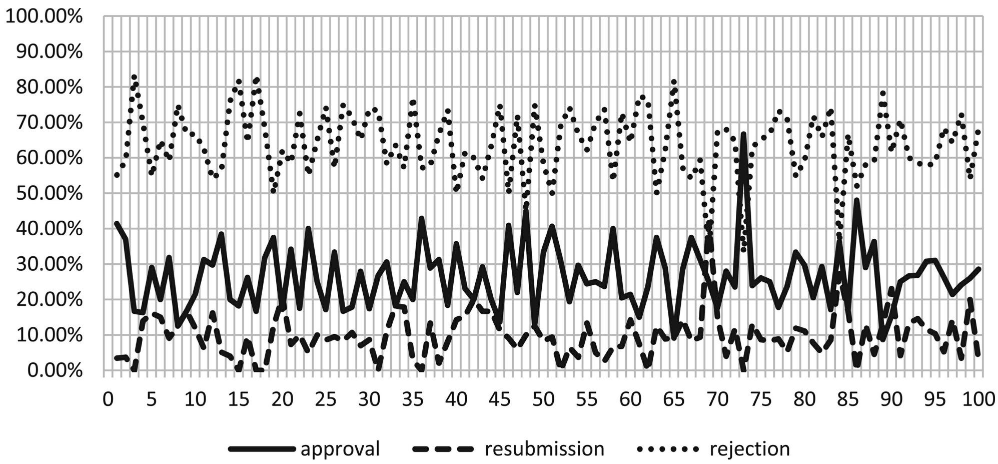


Figure 2. Simulation results for Scenario 2 for the M shape probability distribution.

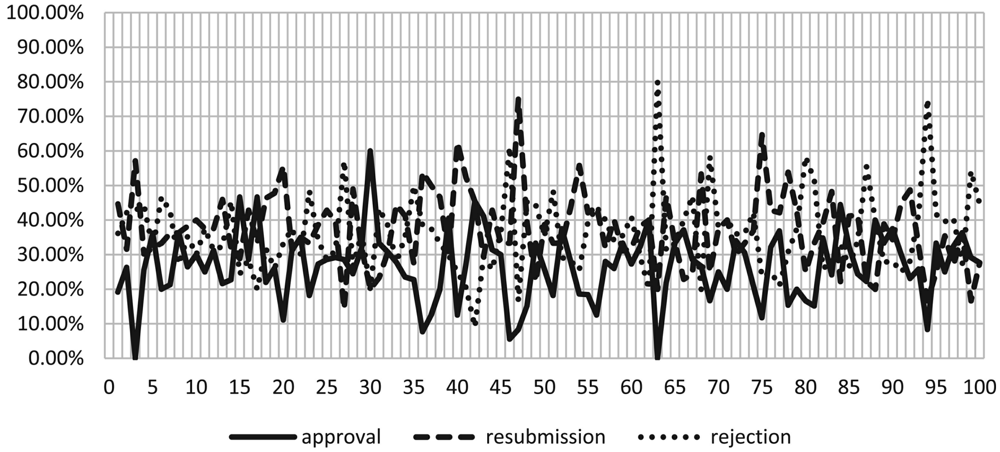


Figure 3. Simulation results for Scenario 3 for the M shape probability distribution.

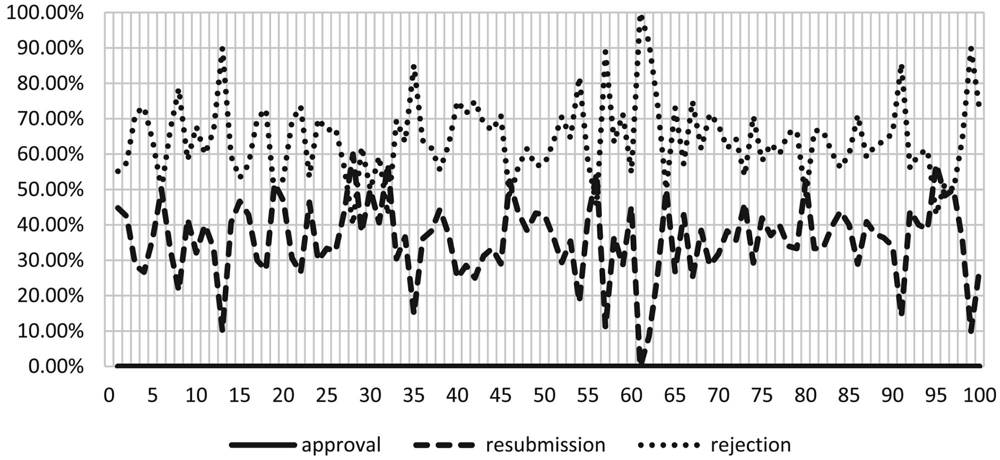


Figure 4. Simulation results for Scenario 4 for the M shape probability distribution.

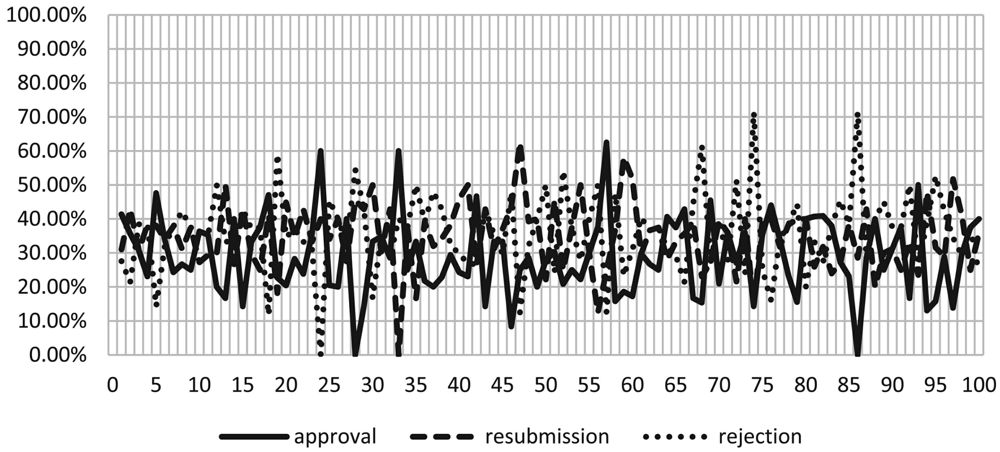


Figure 5. Simulation results for Scenario 5 for the M shape probability distribution.

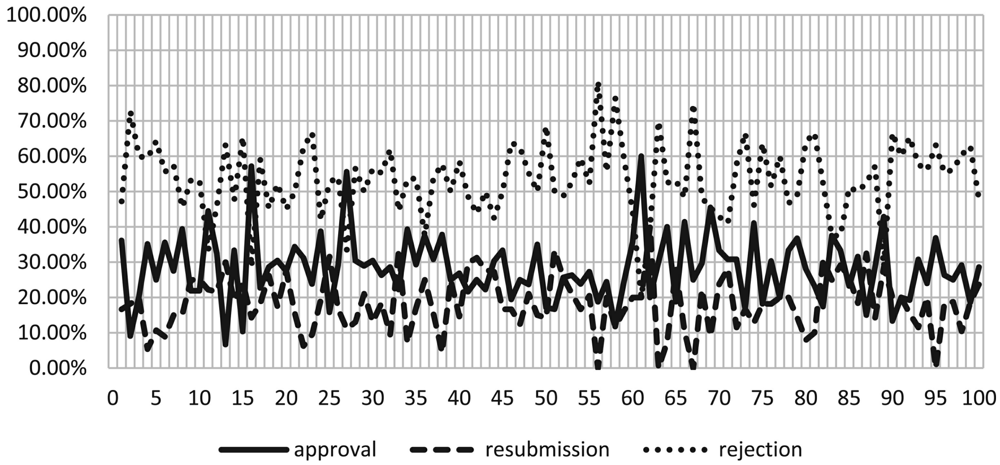


Figure 6. Simulation results for Scenario 6 for the M shape probability distribution.

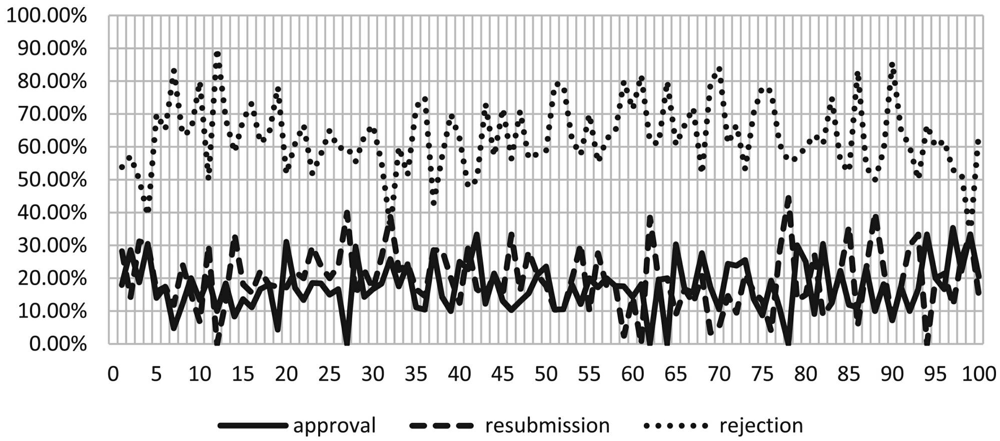


Table 2. Average rates of approval, re-submission, and rejection for the six scenarios with the M shape of probability distribution for case intricacies.

Rate\scenario	1	2	3	4	5	6
Approval	0.26451	0.26598	0.00000	0.29124	0.28284	0.28353
Re-submission	0.09719	0.37361	0.35838	0.34782	0.18250	0.26379
Rejection	0.63831	0.36041	0.64162	0.36094	0.53466	0.45268

As shown in Table 2, the rates of rejection in the current computer simulations are similar to those of choice failure in the original garbage can simulation (Cohen et al., 1972) and is much higher in the computer simulation than the original simulation, which is about 0.05(Lai, 1998). Therefore, we can conclude that the six scenarios impose some strict structure on the collective decision process which significantly decreases the probability that the problems contained in the cases would be solved.

Table 3 shows the average approval rates stratified by probability distributions of case intricacy and scenarios where the columns are types of probability distributions and the rows are scenarios. On the face of it, the distribution patterns of the approval rates for both the scenarios and the probability distributions of case intricacy varied.

Table 3. Average approval rates by probability distribution shapes of case intricacy and scenarios.

	M	*V*	Bell	Down	Up	Even	Reversed	*L*
1	0.26451	0.09051	0.44770	0.34773	0.55673	0.37228	0.72219	0.09051
2	0.26598	0.18261	0.46039	0.36977	0.54620	0.37053	0.72165	0.10028
3	0.00000	0.00000	0.00000	0.08970	0.18006	0.00000	0.00000	0.09399
4	0.29124	0.00000	0.43351	0.18754	0.46888	0.36240	0.75529	0.09643
5	0.28284	0.17433	0.45909	0.35581	0.52797	0.36882	0.74521	0.09549
6	0.28353	0.17352	0.46684	0.37299	0.55957	0.37799	0.71263	0.09241

In order to draw concrete conclusions, Table 4 shows the two-way ANOVA analysis for approval rates based on the data in Table 3. Firstly, three premises for the two-way ANOVA analysis are checked:

- Homogeneity of variance: All the variances are less than 0.02.
- Independence of observations: Each round of simulation is independently run.
- Normally distributed dependent variable: All the simulation results in each round are distributed in bell shapes. An illustrative result of the rates of approval cases under shape M and Scenario 1 is shown in Appendix D.

Table 4. The two-way ANOVA table for the six scenarios and eight probability distribution shapes of case intricacy in

relation to average approval rates.

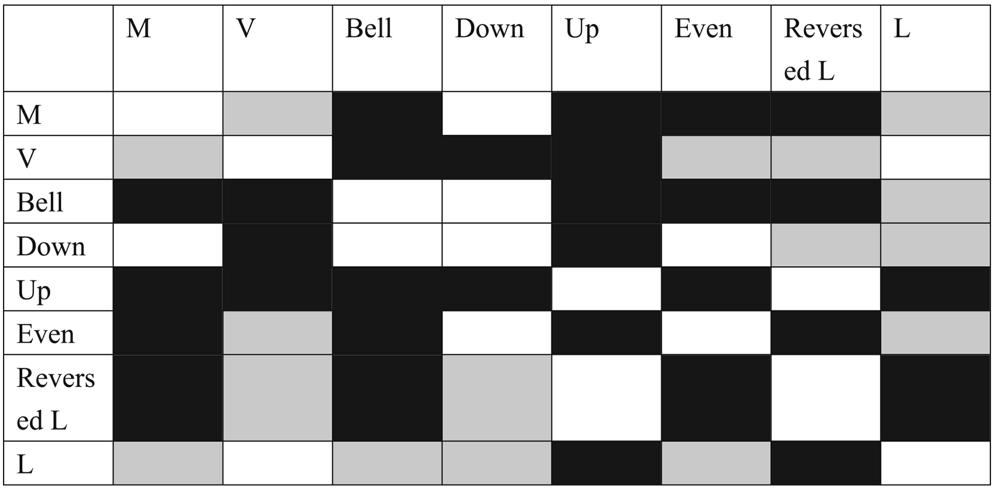
Variables	SS	df	MS	*F*	*P*-value	*F* Crit
Scenarios	0.692964	5	0.138593	14.99613	7.09082E-08	2.485143221
Shapes	1.299543	7	0.185649	20.08774	1.59798E-10	2.285235173
Errors	0.323467	35	0.009242			
Sums	2.315973	47				

Notes: SS: sum of squares; df: degrees of freedom; MS: mean squares; F: F ratio; *P*-value: *P* value; F Crit: F Critical value.

We can conclude from the ANOVA table that both scenarios and probability distribution shapes of case intricacy significantly affected the simulation outcomes so that the differences of average approval rates across scenarios and probability distributions were statistically significant at the significance level of 0.05. In words, both the six scenarios and the eight probability distributions of case intricacy mattered in affecting the average approval rates.

A closer examination of the average approval rates based on a set of pairwise ANOVA analyses between probability distribution shapes of case intricacy is shown in Figure 7. It shows that each case intricacy distribution is significantly different from at least the other distribution. The Up shape is significantly different from the others except the Reversed shape. Each distribution is insignificantly different from exact another distribution except that the Down shape has three.

Figure 7. The pairwise ANOVA analyses of the average approval rates among case intricacy distributions. Black cell indicates a statistical significance level of 0.01, while grey cell 0.05.



Because Scenarios 3–6 are the same except that the review lenience for the reviewers was set to 0.3, 0.5, 0.7 and 0.9, it would be natural to compare the approval rates for the four scenarios in another two-way ANOVA table, which is shown in Table 5. Again, we can conclude that both the four scenarios and the eight probability distributions of case intricacy significantly affected the simulation outcomes so that the differences of average approval rates across scenarios and probability distributions were statistically significant at the significance level of 0.05. A closer examination based on a set of pairwise comparisons between scenarios is shown in Figure 8, where Scenario 3 was quite distinct from all other three scenarios in that the approval rates of it are quite distinguishable statistically from those in all other three scenarios.

Figure 8. The pairwise ANOVA of the average approval rates among scenarios. Black cell indicates a statistical significance level of 0.01, while grey cell 0.05.

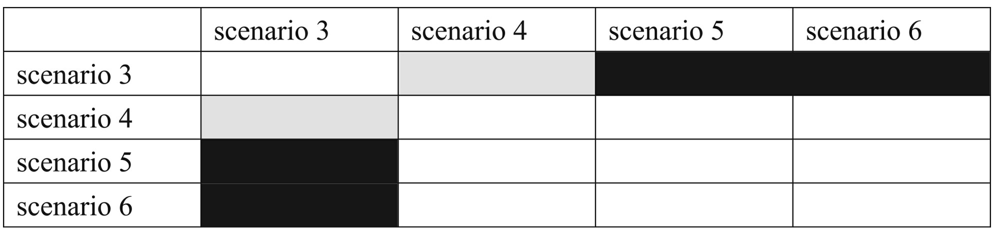


Table 5. The two-way ANOVA table for the last four scenarios and eight probability distributions of case intricacy in relation to average approval rates.

Variables	SS	df	MS	*F*	*P*-value	*F* Crit.
Scenarios	0.609671	3	0.203224	14.48849	2.43627E-05	3.072467
Shapes	0.715072	7	0.102153	7.28284	0.000175496	2.487578
Errors	0.294558	21	0.014027			
Sums	1.619301	31				

Notes: SS: sum of squares; df: degrees of freedom; MS: mean squares; F: F ratio; *P*-value: *P* value; F Crit.: F critical value.

We can conclude, in general, that both the six scenarios and the probability distributions of case intricacy matter in that they affect the average approval rates in the computer simulations. In particular, the same conclusion can be drawn for the last four scenarios, that is, Scenarios 3–6. Pairwise comparisons show that each shape is quite distinct from all other probability distribution patterns and so is Scenario 3 in comparison with Scenarios 4, 5 and 6, respectively. The implication is that an effective institutional design in general, and planning and design review process in particular, must take into account probability distributions of case intricacies. For example, an institutional design that works in a situation where case intricacy is symmetrically distributed as M shape might behave differently in another situation where case intricacy is linearly distributed.

5. Discussion

The justification of the simulations can be done by comparing the simulated approval rates at the initial meeting as 40.59%, 68.88% and 90.46% with roughly correspondent review leniencies of 0.5, 0.7 and 0.9, respectively. It supports that the results of the computer simulations would be reliable and our conclusions sound.

In the current simulation design, the cost (indicative of time) for searching solutions is implied by the quality of solutions. In other words, there might be correlation between the investments in searching for solutions and solution quality. For example, when a case with a higher level of intricacy, the members in the review meeting would spend more time in looking for appropriate solutions or alternatives for the case under consideration. Such investments require resources of time and labour and would thus enhance the quality of the sought out solutions. In addition, there is uncertainty about what solutions would come about during the search process (Hopkins, 1981). Both the investments in and uncertainty about alternatives are the cost of searching for good solutions.

The current simulation design did not consider the learning effects of the case owners whose cases were returned for re-submission. That is, when a case is returned for re-submission, the applicant has learned significantly from the review process and when she or he resubmits the case next time, it would be improved significantly with a change in case intricacy. The learning issue is difficult to deal with, but must be taken into account to attain realism.

All the absolute values of case intricacy, solution quality, and review lenience range from zero to one. These numbers do not have substantive meanings; they are indicative of relative strengths of the factors that affect the decision of whether to accept a case or not. They could be thought of as utilities, positive for solution quality and review lenience and negative for case intricacy. The original garbage can model used the term ‘energy’ indicative of resources to represent these numbers, but we argue that the conception of utility might be more appropriate for explaining the meanings of these numbers. That said, the notion of utility itself is a difficult issue to deal with because it encounters the controversy of interpersonal comparisons of utility (Keeney & Raiffa, 1976). In addition, there is a distinction between decision utility and experienced utility that must be addressed if the notion of utility is adopted seriously in the model (Kahneman, 2011). Regardless, if we assume that the issue of interpersonal comparisons of utility could be resolved through scale normalization and that the notion of utility adopted in the model takes into account both decision utility and experienced utility by a weighted, composite utility of the two, the values of the three variables could be interpreted in a meaningful way as utilities (Lai, 2021).

Small group organizations can be viewed as complex systems (Arrow, McGrath, & Berdahl, 2000). Because of the complexity, it is difficult to analyse organizational choice behaviour in real settings. Instead, we conduct computer simulations to explore the collective decision-making behaviour of the small groups as planning review committees. Computer simulations are an effective analytical tool for understanding complex systems, such as the economy and the city (Arthur, 2015; Batty, 2005), exactly because computer simulations have the merits of both deductive logic and inductive experiments. However, the results in the computer simulations presented in this paper could be enhanced if the design of these simulations could be more structured in an experimental design as commonly adopted in psychological research (e.g. Lai, 2006). Regardless, the simulation findings presented here could be supported through replication by psychological experiments on human subjects. To a large extent, we have simplified the garbage can model to impose strong structures on the planning review meetings simulated. Still, in real settings, such meetings may not be as orderly as assumed and can be very complex so that uncertainty pervades. In order to capture such realism, in the future, we could relax the assumptions of the model, for example, by allowing decisions other than acceptance, resubmission and rejection of cases to be made, including flight or oversight decisions as presented in the original garbage can model. Regardless, we have shown in the current formation, structures as manifested by the coupling between problems, solutions and decision makers bring about order and the immediate research question is: How much order is desirable for a complex system? In the context of urban development, a complete order implies equilibrium and death and the city is most viable if it can stay in a state that is at the edge of order and chaos, or a critical state (Bak, 1996).

6. Conclusions

When faced with complexity, people tend to seek order and in the current computer simulations one way of imposing such order on complex decision processes is through institutional design. Based on the garbage-can model, the 4800 computer simulation rounds with up to 50 cases for each round strongly suggest that institutional design of collective decision making brings about order in that the rates of approval, re-submission, and rejection in the planning review context fluctuate on a stable level, reminiscent of El Farol Bar problem (Arthur, 1994). In Arthur's computer simulations, agents are adaptive and capable of learning, while in our simulation agents are non-adaptive and unable to learn. Although the simulation only considers five factors, that is, scenario, probability distribution shapes, case intricacies, committee leniencies and solution qualities, order emerges from chaos due to the strong structure of the institutional designs as manifested by the six scenarios of collective decision making for planning review. Our simulation results show that different institutional designs result in different outcomes of the collective decision making for planning and design review. Thus, a major implication for practice is that an appropriate institutional design has to consider the history of case intricacies, mutual understanding between different levels of review committees, and affordable costs for review committees to deal with cases. In most situations, there is a desire for a high rejection rate with a low average score. It would require an institutional design of sequential meetings organized by strict reviewers. That is, to impose a high rejection rate on the planning review process, an institutional design of sequential meetings participated by the reviewers with high scrutiny records should be implemented to ensure the quality of the proposed land use planning or urban design projects.

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