

**Information and adaptation in a public service sector:
The example of the Dutch Public housing sector**

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ABSTRACT

A public service sector can be conceived as a multi agent system subordinated to a principal, mostly a department of a national government. The agents are relative autonomous and have decisional discretion, as long as they respect the boundaries setup by law and legislation. The hierarchy is less compulsory than in a command-and-control structure. Central control opponents presume more adaptational capacities of semi-autonomous organizations. The line of thinking is that the distributed intelligence structures can cope better with variance in circumstances. Such a multi agent system would be more suitable to handle environmental complexity. The paper gives insight into the way such a particular kind of multi agent system makes decision on issues of adaptation. Empirical evidence from the case of the Dutch housing sector shows that the expectations of scientist and policy makers are exaggerated. The agents use strategies which reduces decisional complexity, whereby the adaptation to environmental circumstances is low and arbitrary and rationality of the adaptation is limited by self-reference and overconfidence. This observation provides new thoughts to the ongoing rationality debate.

Keywords: adaptation, MAS, portfolio management, nonprofit, KDD, overconfidence, self-reference, rationality

1. INTRODUCTION

The case in this paper, the Dutch public housing sector, is an example of private nonprofit organizations which are the executioners of public tasks. The number of organizations is decreasing from 552 ultimo 2002 to 400 ultimo in 2010. The organizations are foundations or associations. Their private status provides them the protection of property rights, while the public law gives them certain privileges in comparison to for profit housing organizations [1]. Law and legislation prescribe the objectives, although ambiguously regarding the vagueness of the multiple goals. One goal is to be read in the text of the core regulation: housing corporations are supposed to deal with differing local circumstances, tracking and serving the target groups in their working area, and taking into account the market situation. This expectation is neither operationalized nor instrumentalized, so the text is no more than an intentional instruction given by the public legislator to the private agents. The implementation is left to the own responsibility and discretion of the local agents.

2. MAIN QUESTIONS

The theoretical question is how multi agents systems involve information in decisions on adaptation to the environment. Empirically the question is elaborated: Which kind of information correlates to the decisions made? Which information processing strategies reflect the observations from the case to the Dutch public housing sector?

The two questions need conceptual elaboration. All kinds of information could be discerned, depending on the chosen point of view. For this purpose the following two taxonomies are crossed (see figure 1).

Firstly, the decision process is divided in blocks, each containing types of information:

- Static information, like retrospective statistics on processes and facts in the environment, and statutory objectives.
- Dynamic information, reflecting the working processes in action.
- Conditions for decision making.
- Forecasts of action programs and expected effects of these programs.

This conception is an example of the construction of the ontology [2] of decision-making by housing corporations and owners of real estate portfolios in general.

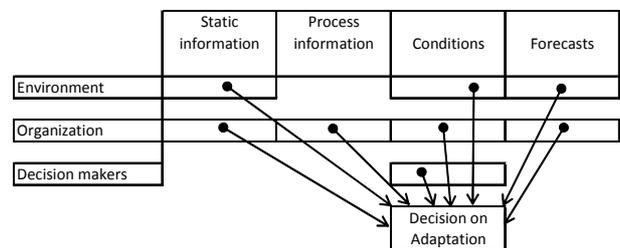
The second taxonomy concerns the level of information, considering the sector to be an open, social and anthropogenic system [3]:

- Environment of the organization.
- Organizational level.
- The level of the decision maker.

Because of the aggregation level of the data set, the level of separate decisions is not available.

The level of the decision makers requires some explanation. Although organizations ought to be considered as impersonal system of human effort, the function of the chief executive has personal aspects according to Barnard [4]. The chief executive has influence on which information is admitted to the decision making, clearly illustrated in situations of groupthink [5]. Assuming this, the CEO has a determining role in the complexity of the decision making. Also the CEO is a major 'node' in the linkage between organization and sector networks, bringing in ideas for innovation and so on. The two taxonomies are crossed in next figure, and filled with information items which are possibly relevant to a service delivering organization.

Figure 1 Conceptual model



Not all cells of the table are filled, due to limitations of the data set. Transactions in the working area could comprise relevant information. Most missing cells are on the decision maker's level. Items like education, tenure, incentive compensation contracts, reputation, personal values, heuristics, beliefs, scores

on overconfidence scales, etcetera would be interesting and should get attention in further research. Yet, we make do with what we have at this moment.

Information strategies

The second question is what information strategies can be observed. Simon [6] coined the concept of bounded rationality. March [7] applies this concept to organizational decision making. Bounded rationality implies that decision makers cannot process all incoming and available information. They have the intention to be rational but they are as humans restricted by computational limitations. However, limited use of information can also be attributed to an adverse choice of heuristics [8], for instance when they rely on intuition in issues which were better handled with cold headed arithmetic. Barnard [9] addresses this phenomenon in an essay in which he introduces a useful taxonomy of types of information:

- Precise information, like business registers.
- Hybrid information, neither complete nor unambiguous, but probably most relevant to the problem issue of the decision maker.
- Speculative kind of information.

Regarding the subject of rationality Luhmann [10] provides a differentiation. Rationality is usually conceived as guided by objectives. In his opinion however, three kinds of rationality have to be considered:

- Guided by objectives and rules.
- Attracted by perceptions of chance.
- Assignment to a problem solving approach.

Luhmann reveals strategies of complexity reduction. Firstly, if the relations between situation, objectives, actions, and effects are undetermined, inner complexity of the system will be low. In other words, the degree to which collected information, outspoken objectives and decisions are related, is varying. Secondly, the connection of social systems to their environment is indirect and interfered by self-reference [11]. The implication of this theory is that references that the necessity and the success of adjustments to the environment will be proved by prepossessed beliefs and opinions inside the organizations.

If success of action is believed to be predetermined, we encounter the phenomenon of overconfidence. In this paper overconfidence is put in an informational frame. In spite of uncertainty and risks not all available and relevant information is used for the decision making, relying on a delusion of success [12]. Charness and Gneezy [13] show that when complexity reducing techniques like portfolio analysis are applied to highly complex problems, the perception of risks will decrease substantially. Presumably, information regarding the risks will be rather avoided than digested.

3. DESIGN AND OPERATIONALIZATION

The research is an example of knowledge discovery in databases (KDD) [14] applied to an open multi-agent system of public housing providers.

Adaptation

Adaptation is conceived as a deliberate adjustment of the housing portfolios to norms, demands, and market forecasts. Portfolio analysis implies separate decisions investments and divestments [15]. However, project decisions are aggregated in

the data set to the level of the organizations and report years. Portfolio adjustments are realized by means of:

- Acquisition of houses from other owners and landlords.
- Building of rental houses.
- Building of houses for sale.
- Sale of existing rental houses.
- Demolition and joining small houses to a smaller number of large houses.

The last two bullets represent divestments. The last item is a combination of two measures due to an aggregation in the provided original data set.

Operationalization of the input variables

A selection is made of variables in the data set to cover the scheme of potentially relevant information items.

Figure 2 Scheme with input items

	static information	proces information	conditions	forecasts
environment	regulatory objectives		local arrangements	long-term market
	local stock composition		local field position	
	demographics			
organization	statutory objectives	actual supply	size	
	own stock composition	actual demand	assets	future assets
		fit demand supply	hidden assets	
decision makers			prominence in fields	

Some remarks on the variables. The regulatory objectives on the environmental level are equal to all organizations, for which reason they are not selected as variable. Housing corporations have to comply to these objectives in order to be admitted, so there is neither differentiation in the statutory objectives. Analysis of 144 of the 522 annual reports does not show differences between by state prescribed objectives on the one hand and the expressed operational objectives on the other hand. This smaller sample includes also the variable local arrangements on objectives and agreed performance. The items are elaborated into 26 variables.

Some remarks can be made. One of the variables is the size of the organizations, because of regulatory practices expressed in the number of rental houses and other objects in exploitation. The point of view determines whether size of an organization is a (human) resource or an attribute for the position in the local field. Study of motivation to mergers in the annual reports shows both points of view. In this paper organizational size is conceived as an attribute of resources. The organization field position is measured as 'prominence' by a combination of two variables, one measuring the activity of the chief officers as speaker on national symposia and the other measuring the participation of chief officers in committees of the national sector organization. The first variable is weighted twice.

Hypotheses

Each independent variable has an implicit hypothesis. Assumed is that all variable are correlated to adaptation decisions. If not, the null hypotheses cannot be rejected. For the sake of reader's digest, the paper leaves the null hypotheses unmentioned, and only presents values if a variable has a significant correlation.

Hypotheses on informational strategies

The question on the informational strategies is elaborated in sub questions.

In the paper the question on informational strategies is elaborated in sub questions:

1. *Do organizations use all available information (full use)?*
Full use is measured true if all cells are covered by significant variables. This hypothesis is tested for each dependant variable and for the aggregate.

2. *Or, are they limited by computational limitations (bounded rationality)?*

Bounded rationality is found if only one or two cells are covered by significant values, assuming that information is restricted to simple one-to-one or two-to-one causations.

3. *Which of the three kinds of rationality is reflected by the patterns of information selection: a) guidance by objectives, b) chance orientation, or c) problem solving approach?*

Problem solving rationality is ascertained if one of three variables (fit between supply and demand, vacancy, satisfying low income households' demand) has the highest partial correlation value in the estimation models. In those cases is assumed that adaptation is a reaction on direct observable disturbances in the public service delivery.

Chance orientation is difficult to measure. In the data the variable for hidden assets is used as indicator for an orientation to chances.

Guidance by objectives is not operationalized, but the disassociation between objectives and action (see 8.)

4. *Which type of information is preferred: a) precise, b) hybrid, or c) speculative?*

From the information type taxonomy only the precise information is selected. Precise information is determining adaptation if only static information items have significant correlation values.

5. *Can self-reference be ascertained in the balance between information inside and outside the organizations?*

Self-reference is tested by measuring the correlation values on the row of the organization in comparison to the values on the level of the environment. If in the row of the organization two cells contain the highest correlation scores, self-reference is ascertained.

6. *Are information-reducing scopes like self-reference and closure attributes of the process or of the position of the organization?*

Self-reference on the action is the case if the level of precedent investment activity determines the decision on future adaptation. This is called inertia, and is proven if the investment level in the preceding years has the highest t-value in the estimation model. Process closure is ascertained if only the organization row contains significant correlation values. Position closure is the case if only the condition column holds significant values.

7. *Do the observations show signs of overconfidence?*
Overconfidence is not tested by a hypothesis but deduced by argumentation. Indicators are low use of presumably relevant information items in relation to the decision.

8. *Are there indications of disassociation between objectives and actions?*

This question is also answered by argumentation.

Methods

Empirical evidence comes from a data set (2002) provided by Dutch regulatory agency and supplemented with demographic

and market information. On most items the data set covers the whole population of agents (N = 552).

Testing is made by multiple regression according to the Tobit method. This method is of use for data set where the dependant variable has restrictions. The restriction in this inquiry is that there are both zero values, and a descending range of values approximating zero.

The sets of independent variables are controlled for collinearity by a series of Pearson bi-variate regressions. Variables with a significant correlation to the dependant variable are selected and used as input for the Tobit regression analysis. The measured t-values are presented in the result schema as far as the selected variables correlates significantly. Thresholds for significance are in descending order 1%, 5%, and 10%.

4. ANALYSES

The use of information is described by means of filled version of the input scheme. Subsequently the hypotheses on information strategies are tested. The procedure is done for each of the five items of portfolio adaption.

Acquisition

The first dependant variable concerns the acquisition of houses from other owners and other landlords.

Figure 3 Scheme with results on acquisition

Tobit regression Acquisition n=521	static information	process information	conditions	forecasts
environment				
organization		Supply to low-incomes households (1.9901**)	Size (1.9309*)	
decision makers			Prominence (1.8489*)	

1. Full use of information not the case.
2. Bounded rationality is tested false because of the measurement of 3 significant.
3. Problem solving rationality is ascertained, because the supply presents the highest t-value. The variable for hidden assets has not a significant score, so chance orientation is not found.
4. Static information items do not show significant correlations. Therefore there is not a preference to precise information.
5. The self-reference on the organizational level requires two highest scores in the row. This is the case, so the hypothesis is accepted.
6. Inertia is not found, because the investment level in preceding years has not a significant score. Process closure is not observed, because of significant in other rows than the one of organization. Process closure is tested false, because of significant outside the conditions column.
7. As acquisition is a market depending operation, the absence of correlations to market forecast variables indicates overconfidence.
8. Actual performance in the supply to low-income households is related to the level of acquisitions. The reason for this observation is not clear. There is no clear argument to state a disassociation between objectives and action, so the hypothesis is rejected.

Building new rental housing

Building of rental houses is a core business of housing corporations, because it achieve a renewal of their stock. The following significant correlations are found.

Figure 4 Scheme with results on building rental houses

Tobit regression building rental housing n=447	static information	process information	conditions	forecasts
environment				
organization	Share low quality houses (1.6965*)	Investments preceding years (3.8194***)		Δ Solvability (-6.4146***)
decision makers				

1. The full information hypothesis is easily rejected.
2. Bounded rationality is tested false.
3. Problem solving rationality is not ascertained, because of the fact that low quality is not chosen as indicator of a problem solving approach. The variable for hidden assets has not a significant score, so chance orientation cannot be stated.
4. One static information item has a significant correlation, but there are other kind of information items.
5. The self-reference on the organizational level requires two highest scores in the row, so the hypothesis is accepted.
6. Inertia is found, because the investment level in preceding years has a significant score. Process closure occurs when significant information is only found in the organization row. This is the case. There are no significant scores in the condition column, so position closure is not ascertained.
7. Although low information dependency is observed, there are at first glance no arguments for stating overconfidence. However, taken into account the negative correlation to the solvability trend, building of new rental houses should give financial concerns. However, the decisions are indifferent to the actual financial state, although the financial impact of the decision is remarkably negative. So, it is allowed to indicate overconfidence. Also the indifference to market forecasts supports the claim of overconfidence.
8. The results suggest that another objective plays a role, namely a concern on technical quality. The regulation comprises a quality objective, namely the maintenance of the level of quality. Therefore there is no ground for the statement of objective disassociation.

Building houses for sale

Building houses for sale is not a traditional activity to housing corporations. However shortage of affordable owner-occupied houses could bring housing corporations to invest in such houses. The next figure shows on which items the choice between activity and no activity depends.

Figure 5 Scheme with results on building of houses for sale

Tobit regression building houses for sale n=429	static information	process information	conditions	forecasts
environment	Share owner-occupied houses (-2.1967**)			
organization		Investments preceding years (7.7763***)	Size (6.9819***)	
decision makers				

1. The full information hypothesis is rejected.
2. Bounded rationality is tested false, because of the observation that more than two cells are covered.
3. Problem solving rationality is not ascertained. The variable for hidden assets does not have a significant score, so the hypothesis on chance orientation is rejected.
4. One static information item shows a significant correlation. However the correlation is not exclusive, so the preference to precise information is not proven.
5. The self-reference on the organizational level requires two highest scores in the row. This requirement is met.
6. Inertia effect is found, because the investment level in preceding years has the highest t-value. Process closure occurs when significant correlations are only found in the organization row. This is not the case. The significant correlation scores are not restricted to the condition column, so position closure is absent.
7. Considering that building of houses is not a core business and housing corporations have to operate in a demanders' market, it is astonishing to observe indifference to market forecasts. Therefore overconfidence can attributed to the decision to develop houses for sale. The inertia observation enhances the risk of building for periods without demand.
8. There is no correlation to forecasted demand from buyers of low-priced houses. The correlation to the share of owner-occupied housing stock in the municipalities could reflect considerations with the local housing policy. However, the type of housing is private and the potential demand of low-income has no influence, so a disassociation between objectives and action is stated.

Divestment by sale of existing rental houses

Sale of existing rental houses can serve certain objectives. Common practice is that investment in new rental houses is combined with sale of existing houses. The analyses provide the following results.

Figure 6 Scheme with results on sale of existing rental houses

Tobit regression sale rental houses n=475	static information	process information	conditions	forecasts
environment	Low-income households (-2.0787**)			
organization		Vacancy rental houses (3.6062***)	Size (4,1785***)	Solvability (-1,8133**)
decision makers				

1. The full information hypothesis is rejected.
2. Bounded rationality is tested false too.
3. Problem solving rationality is ascertained because of the significant correlation of vacancy to the sales. However the t-value of Size is higher, therefore the problem orientation is not leading. The variable for hidden assets has no significant score, so chance orientation is absent.
4. One static information item shows a significant correlation. However the correlation is not exclusive, so the preference to precise information is not proven.
5. The self-reference on the organizational level requires two highest scores in the row. This requirement is met, so the decision is characterized by organizational self-reference
6. Inertia effects are absence, because the investment level in preceding years has no significant score. Process closure occurs when significant information is only found in the organization row. This is not the case. The significant

correlation scores are not restricted to the condition column, so position closure is absent.

7. Decisions on sale of rental houses are made without sensitivity for market forecasts. Consequently, the profits of a sale program might be overestimated, so also on this decision overconfidence is observed.
8. The decision to sell houses has a negative correlation to the share of low-income households in the local situation. This indicates a reverse response. However the regulation mentions also the aspect of livability, an objective that in state documents is associated which a policy against geographical concentration of low income groups. Ambiguity of regulatory objectives is a reason to reject the hypothesis of disassociation between objectives and actions.

Divestments by means of demolition and joining of houses

The number of houses in stock decreases by demolition and the practice of joining small houses to larger ones. Analyses of the decision on these divestments have the following results:

Figure 7 Scheme with demolition and joining of houses

Tobit regression divestments n=521	static information	process information	conditions	forecasts
environment	Share owner-occupied houses (-1.6930*)			
organization	Share apartments (-2.0613**) Hidden assets (-1.9598*)	Vacancy rental houses (3.1094***)	Size (5,7346****)	
decision makers				

1. Here, the full information hypothesis is also rejected.
2. Bounded rationality is tested false, because more than two cells are covered.
3. Problem solving rationality could be ascertained, when not the t-value of Size would be higher. The variable for hidden assets does have a significant score, so chance orientation is found. The negative value implies that corporations with hidden assets are more reluctant to demolish or join their houses.
4. Two static information item show significant correlations. However the correlations are not exclusive, so the preference to precise information is not proven.
5. The self-reference on the organizational level requires two highest scores in the row. This requirement is met, so the decision is characterized by organizational self-reference.
6. Inertia effect is absent, because the investment level in preceding year does not have a significant score. Process closure occurs when significant information is only found in the organization row. This is not the case. The significant correlation scores are not restricted to the condition column, so position closure is absent.
7. There are no arguments to state overconfidence.
8. The divestment decisions are depending on characteristics of the housing stock. As mentioned before, quality aspects are connected to a second statutory objective. So, there is no ground for stating a disassociation between objectives and action.

Results summarized

The paper has to deal with two questions: firstly which information is related to organizations' adaptation, and secondly, which information strategies can explain the observed

sensitivity to information items. The answer on the first question is presented in the next table.

Figure 8 Information items correlated to portfolio decisions

Aggregation of portfolio adjustments	static information	process information	conditions	forecasts
environment	Demographics • Local stock ••		Local field position	Long-term market
organization	Own stock • Quality -	Vacancy •• Actual supply •••	Size •••• Assets ••	Δ Solvability •
decision makers			prominence -	

significance to 1% •
significance to 5% •
significance to 10% -

The used items are spread over the scheme. The implicit hypothesis was that the selected information items would be relevant to the decision making. Market forecasts do not make difference to portfolio decisions. Local field position is irrelevant. Remarkably, size is the most prominent variable. It has more influence on adaptation than public housing issues. It could be that more human resources are available. It might be a matter of position as well: bigger corporation have presumably more power to impose portfolio adjustment upon actors in their environment.

Several hypotheses are postulated regarding to the information strategies, based on rationality types and heuristics. In the following table the summarized result of the analyses is given.

Figure 9 Results on testing information strategies

Hypotheses test results	Actions					Aggregate Total
	acquisition	investment rental	investment for sale	sale of rental stock	divestments (demolition)	
Full use						False
Bounded						False
Problem oriented	True					1 True 4 False
Chance orientation	True				True	1 True 4 False
Preference precise						False
Selfreference org. level	True	True	True	True	True	True
Inertia			True			1 True 4 False
Closure process		True				1 True 4 False
Closure position						False
Overconfidence	True	True	True	True		4 True 1 False
Task avoidance			True	True		2 True 3 False

All five analyses are negative on the full use of information items.

The hypothesis of bounded rationality is also rejected. The hypothesis of problem solving rationality is both rejected and accepted. Items indicating problem orientation are found, however they have lower t-values than other items.

The hypothesis of chance oriented rationality is found at acquisition and divestment decisions. At the building and sales decisions the chance orientation is absent.

The hypothesis of a preference to precise information is rejected overall.

The hypothesis on organizational self-reference is accepted in all five issue of portfolio adjustment, bearing for a large part on the influence of Size in the regression analyses.

The inertia hypothesis is only confirmed in the decision to build houses for sale. This is an intriguing result for a commercial activity in a competing market. For that reason the observation is related to overconfidence. Insight observations of the organizations demonstrate that housing corporations set up departments for commercial real estate development. Probably

production becomes a goal in itself as soon as such departments are in operation.

Informational closure of processes is only observed in the decision of building new rental houses. A probable explanation is that it is a self-inducing routine of housing corporations.

Informational closure related to position is overall rejected.

The overconfidence hypothesis is not tested straightforwardly, but by argumentation. On four portfolio issues argumentation indicates overconfidence, so overconfidence is a rather present attribute of portfolio decisions by housing corporations.

Disassociation between regulatory objectives and actions is indicated by argumentation on two issues. The confirmation concerns building of houses for sale and the sale of existing rental houses. A tentative explanation for this observation is that these commercial activities trigger goal displacement.

5. CONCLUSION AND DISCUSSION

The paper has to deal with two questions: firstly which information correlates to organizational adaptation, and secondly, which information strategies can explain to the observed sensitivity to the information items. Adaptation is operationalized as portfolio adjustments by Dutch housing corporations. Empirical evidence is based on a data set of annual report information (2002), supplemented with demographic statistics and market forecasts.

Answering the first question, it is remarkable that Size of the organization dominates the portfolio decisions. Also notable is the insignificance of market forecasts and financial concerns. Self-reference and overconfidence appears to be the most significant information strategies of housing corporations.

The operationalization of 3 strategies, namely full use, bounded-rationality and preference of precise information might be reconsidered for future research.

The research has been designed to provide insight in the relation between information and adaptation in a public service sector. Starting point was the expectation of policy makers that a privatized multi agent system would have more capacity to deal with local differences. The paper is not set up to prove or to reject the expectation of Dutch policy makers, however it gives a lot of second thoughts.

Do the results converge or diverge with other inquiries into the Dutch housing sector? De Kam [16] concludes that building of houses for sale has a weak correlation to market circumstances, and a strong relation to internal attributes of the organizations. Nieboer [17] indicates on basis of interior observations in case studies, that although general portfolio policy comprises market information and demand of target groups, actual investment decisions are decoupled from this policy.

The research design has obviously blank spots, so more and other information on the environmental and personal level could shed new light on the relation between information and adaptation. A data set which allows longitudinal research would be welcome. More comprehensive information could provide higher correlation values of multiple regression models, although the scores presented are not uncommon for research into social systems and institutionalized environments.

At the end one question remains: can the results of the paper be generalized to other sectors. The Dutch housing corporations are an example of nonprofit organization. Nonprofit

organizations have other drives than the profit maximand, even if they expand to commercial activities. So a generalization to other nonprofit sectors might be considered, especially if their public task comprises investments and divestments. Although a transfer of results to profit sectors is not recommendable, application of the research design to these sectors would be a challenge. Can we find the homo economicus, or do we find organizations which apply complexity reducing strategies when they have to decide on adaptation?

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