DECISION CRITERIA AND THEIR SUBJECTIVITY IN CONSTRUCTION PROCUREMENT SELECTION

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INTRODUCTION

The escalating requirements of clients on project time, cost, quality and risk have given rise to the development and use of alternative construction procurement systems (Fellows, 1993). However, since each procurement system has its distinctive characteristics, advantages and constraints, there is hardly any single best system that could suit all kinds of clients and projects (Nahapiet and Nahapiet, 1985). The selection of procurement system therefore becomes a very important task for clients, as employing an inappropriate procurement system may lead to project failure (Chua et al., 1999). The consequence may be time and cost overruns and/or general dissatisfaction (Bennett and Grice, 1990; Sharif and Morledge, 1994).

Despite its significance, many clients have been selecting procurement systems in a cursory manner, and some clients even use a specific procurement system by default without making a deliberate choice (Masterman, 1992). A recent UK study (Hibberd and Djebarni, 1996) showed that 89% of respondents were dissatisfied with the procurement system they had previously employed. Inexperienced clients often have to rely on expert advice when selecting a procurement approach and this could result in inappropriate decisions with unforeseeable consequences (NEDO, 1985). Experienced clients may also suffer if they simply based their selection upon biased past experience and the conservative decisions of their in-house experts (Masterman, 1992).

The need for selecting and using an appropriate procurement system for a particular construction project, together with the proliferation of differing procurement systems, calls for more systematic methods of selection (Skitmore and Marsden, 1988). To do this, decision criteria pertinent to the selection of procurement approaches and their properties (i.e. subjectivity) must be carefully identified and evaluated. This paper reports the findings of an Australian study focusing on procurement selection criteria. The subjectivity of the identified criteria is considered and their effects on procurement selection are examined.

CRITERIA FOR PROCUREMENT SELECTION

According to Masterman and Gameson (1994), the selection of an appropriate procurement system depends largely on the accurate identification of client requirements. Many researchers have attempted to arrive at a list of client requirements that might affect the selection of a procurement system, and the outcomes of these studies are summarised in Table 1.

Speed

This refers to the need to complete a project more quickly than other projects of similar nature, complexity and size. Shorter construction duration can be achieved by accelerating or fast-tracking some key phases in the construction project, and this would favour the use of design and build or management contracting (Rowlinson and McDermott, 1999). Since the requirement for a speedier completion could often result in a premium both in the price and quality of construction, a strong justification for speed would be desirable.

Certainty of completion time

This relates to the degree of certainty that a project will be completed on the exact date and time specified in the contract. Time certainty is a crucial need of clients, particularly for those involved in large or prestigious projects scheduled for a particular function or event. There is a strong connection between the certainty of time and speed: the greater speed a procurement system can offer, the higher the degree of certainty that the project can be completed on time.

Table 1: Summary of client's needs for a construction project

Client's needs	Description	Authors
Speed	Speedy procurement process, e.g. a desire to have the project completed as soon as possible.	Bennett and Flanagan (1983) NEDO (1985) Skitmore and Marsden (1988) Singh (1990)
Cost certainty	Price and the stipulated time and knowledge of how much the client has to pay at each period during the construction phase. A reduction in unanticipated extra cost over-run	Hewitt (1985) NEDO (1985) Skitmore and Marsden (1988) Singh (1990) Masterman and Duff (1994)
Time certainty	Degree of certainty that the project will be completed on the date, which is agreed by client and contractor when signing the contract. A reduction in unanticipated extra time over-run.	Hewitt (1985) NEDO (1985) Skitmore and Marsden (1988) Singh (1990) Masterman and Duff (1994)
Flexibility	Ability to accommodate design changes during both design and construction periods	Bennett and Flanagan (1983) Hewitt (1985) NEDO (1985) Skitmore and Marsden (1988) Singh (1990)
Responsibility	An involvement in, and a need to be kept informed about, the project throughout its life	Bennett and Flanagan (1983) Hewitt (1985) NEDO (1985) Skitmore and Marsden (1988) Singh (1990) Masterman and Duff (1994)
Complexity	Client may specify innovative design/ high technology building and require particular subcontractor, or constructability analysis	Bennett and Flanagan (1983) NEDO (1985) Skitmore and Marsden (1988) Singh (1990)
Quality level	Contractor's reputation, aesthetics and confidence in design. A building which reflects the clients activities and image	Bennett and Flanagan (1983) NEDO (1985) Skitmore and Marsden (1988) Singh (1990)
Risk allocation / avoidance	A wish to identify risks and uncertainties during the procuring process	Bennett and Flanagan (1983) NEDO (1985) Skitmore and Marsden (1988) Singh (1990)
Price competition	Covering such issues as value for money, maintenance, costs and competitive tendering.	Bennett and Flanagan (1983) NEDO (1985) Skitmore and Marsden (1988) Singh (1990) Masterman and Duff (1994)
Disputes and arbitration		NEDO (1985) Skitmore and Marsden (1988) Singh (1990)

Certainty of price

Some clients may need to have a firm price for their project before committing to it. Price may include design fees, construction costs, financing costs and management fees. According to Turner (1990), "certainty" should not be conceived as an absolute assuredness, but instead a relative or sliding scale, i.e. "how certain" the price that a procurement approach could offer. Procurement approaches offering the highest price certainty include design and build or the traditional lump sum method.

Quality level

This requirement has three components: quality of materials, workmanship and the design concept. When high levels of quality of materials and workmanship are required, a more stringent supervisory and checking process must be adopted, and one would expect that the speed and price should be more flexible to cater for the required quality standard. Design quality is determined by the experience of the designer, and the cost and time available. The contractor's construction experience may contribute to the quality of design solutions if management contracting is employed.

Flexibility

Flexibility is about the ability to accommodate variations, such as design changes (Bennett and Flanagan, 1983), during the construction phase. Flexibility is particularly needed for large and complex projects or when the exact requirements cannot be carefully established before tendering. Management contracting allows more variations to be introduced without provoking significant contractual claims.

Responsibility

Responsibility is directly related to the degree of client involvement and control over the procurement process. Some clients may prefer to have a single point of responsibility, and hence reduce their exposure to risk. If the clients have in-house expertise to manage the diversified responsibilities created in a project, traditional and management systems will be more suitable.

Complexity

This reflects the client's desire for the final building product to be highly specialised, technologically advanced or highly serviced (NEDO, 1985). Projects with greater complexity may call for the use of traditional methods, as design can be fully developed before tendering proceeds. Management-type procurement approaches may also suit complex projects as a management contractor can participate in the early design stage and provide advice on buildability.

Price competition

Price competition covers such issues as value for money, maintenance, costs and competitive tendering (NEDO, 1985). Many public clients, to satisfy public accountability requirements, must seek competitive tenders. Private clients also favour competitive tendering for commercial reasons. Turner (1990), however, asserts that speed, time certainty, quality level and the complexity of the building may restrict the level of price competition.

Risk allocation/avoidance

This requirement reflects the degree to which the client wishes to transfer the risks of cost and time slippage to the contractor. In choosing a certain procurement system, it is important for the client to know how and to what extent the risk has consciously been passed to another organisation, how it has been shared, how the risk may not have been passed on at all, or indeed how the risk to his organisation may have been increased by the employment of another organisation.

RESEARCH METHOD

Semi-structured interviews were conducted to establish the decision criteria currently used for selecting procurement systems and to determine the subjectivity of those criteria. To ensure that in-depth knowledge of procurement selection was obtained, people in the sample had to:

- have good theoretical knowledge and practical experience in different building procurement methods
- have been actively involved in the process of selecting building procurement systems
- understand the methods of procurement selection.

Since it would be difficult to identify suitable samples that meet all above considerations, purposive sampling and snowball sampling were used (Burgess, 1989). Purposive sampling requires researchers to identify experts who have the potential to provide

the necessary information. Snowball sampling, however, requires individuals engaging in the initial interviews to identify and recommend other experts suitable for the study.

A protocol was developed to drive the interviews. The protocol consisted of three parts.

- *Part I — respondent's profile* seeks to establish the knowledge and experience of interviewees on construction procurement
- *Part II — procurement selection criteria* reveals the criteria influencing the client's choices in selecting procurement systems
- *Part III — characteristics of procurement selection criteria* uncovers the interviewees' perceptions of the subjectivity of procurement selection criteria.

The protocol was piloted by two experts not participating in the final interviews. The pilot studies revealed that some questions were ambiguous, while others might lead to biased responses. For instance, some terms in the protocol were not clearly understood by the experts during the pilot studies. The protocol was therefore edited to address the above issues, and definitions of some key terms were incorporated.

RESPONDENTS' PROFILES

Five Australian client organisations were identified that agreed to participate in this study. These included one private and four public client organisations. All interviewees were responsible for managing the procurement of construction works in their organisation (Table 2).

The results of the interviews confirmed that all respondents always performed procurement selection for their construction projects. They all recognised the need to select an appropriate procurement system for each construction project, satisfying the time, cost, quality and risk requirements. This indicated that the respondents possessed a good understanding of procurement selection.

The above finding was confirmed by the revelation of the respondents' practical experience in procurement selection. As shown in Table 2, except for respondent B, who had been involved in procurement selection for almost 10 years, all other respondents had over 15 years experience in procurement selection.

To further establish the suitability of the interviewees, indirect assessments of respondents' knowledge on various procurement systems were conducted. Issues like the different types of procurement systems available in Australia, their advantages and disadvantages, and their application in different circumstances were raised with each respondent. It was found that all respondents had comprehensive knowledge and experience of all those issues, and that they were suitable for this study.

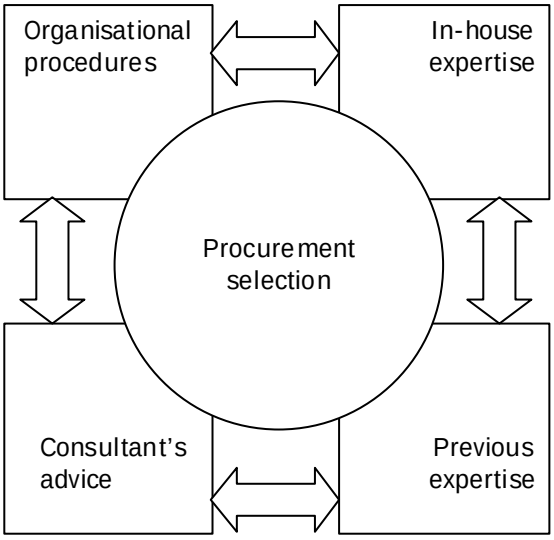
PROCUREMENT SELECTION PRACTICE

All organisations surveyed had their own procedures for procurement selection. Respondent A indicated that many consultants were invited to advise on project characteristics, such as design, complexity, budget costing, and special management requirements. Their advice serves as the basic information for procurement selection. In-house experts then examine the organisation's requirements and, based upon their experience, determine the most appropriate procurement system for the project.

Table 2: Details of interviewees

Ref.	Type of organisation	Position of interviewees	Experience
A	Private client	Manager, Dept. of Planning and Physical Estate	> 15 years
B	City council	Manager, Dept. of Project Management	10 years
C	City council	Manager, Procurement Dept.	> 15 years
D	City council	Manager, Procurement Strategist Dept.	> 20 years
E	Road authority	Manager, Dept. of Project Management	> 15 years

Figure 1: Considerations in procurement selection



According to organisations A, B, C and E, the traditional procurement approach was still the more favourable choice for small projects. For organisations B and C, small projects were those valued at less than $300,000, while small projects were defined by organisation E as those valued at less than $1,000,000. According to the respondents, small projects were normally rather straightforward, and did not require a great deal of design and management skills from the contractors. For projects above the stated value limits, a formal process of procurement selection was required. A variety of issues such as organisational policies, financial regulations, advice from in-house experts, advice from external consultants, previous experience, risks and quality assurance would be considered.

Only organisation D had occasionally attempted to adopt the concepts of theoretical procurement selection as proposed by researchers (e.g. Alhazmi and McCaffer, 2000; Franks, 1990; Griffith and Headley, 1997; Skitmore and Marsden, 1988). However, such application is limited and has never been taken seriously.

PROCUREMENT SELECTION CRITERIA

A list of procurement selection criteria as suggested by the respondents is presented in Table 3. These criteria include speed, time certainty, price certainty, complexity, flexibility, responsibility, risk allocation, quality level, price competition, public accountability, client requirement and political issues.

Compared with the list of procurement selection criteria found in relevant literature (e.g. Bennett and Flanagan, 1983; Hewitt, 1985; Masterman and Duff, 1994; NEDO, 1985; Skitmore and Marsden, 1988; Singh, 1990), the current findings are very similar to those identified in previous studies. The only differences were public accountability, political issues and client requirements, which were not emphasised in previous studies, whereas disputes and arbitration were not suggested in this study. Respondent B explained that public accountability and political issues were considered during procurement selection as the local government was required to demonstrate accountability to the community. As a result, the selected procurement system should be in favour of public accountability criteria such as cost reduction and environmental friendliness.

Table 3: Criteria used for procurement selection

Criteria	Respondents				
	A	B	C	D	E
Speed	✔	✔	✔	✔	✔
Price certainty	✔	✔	✔	✔	✔
Time certainty	✔	✔	✔	✔	✔
Complexity	✔	✔	✔	✔	✔
Flexibility	✔	✔	✔	✔	✔
Responsibility	✔	✔	✔	✔	✔
Quality level	✔	✔	✔	✔	✔
Risk allocation	✔	✔	✔	✔	✔
Price competition	✔	✔	✔	✔	✔
Others		Public accountability		Client's requirements, political issues	Client's requirements, political issues

Note: ✔ represents common selection criterion from the respondent's perspective

Table 4: Subjectivity of procurement selection criteria

Criteria	Respondents				
	A	B	C	D	E
Speed	✔	✔	✔	✔	✔
Price certainty			✔		
Time certainty		✔			
Complexity	✔	✔	✔	✔	✔
Flexibility	✔	✔	✔	✔	✔
Responsibility	✔	✔	✔	✔	✔
Quality level	✔	✔	✔	✔	✔
Risk allocation	✔	✔	✔	✔	✔
Price competition	✔	✔	✔	✔	✔

Note: ✔ represents subjective criterion from the respondent's perspective

Respondents C and D also considered political issues (along with client requirements) as important criteria for procurement selection. Being the public agents representing other governmental departments in construction works, their decisions or their clients' decisions in procurement selection were largely affected by governments' political policies.

Although disputes and arbitration were not directly mentioned by the respondents in the interviews, as key procurement selection criteria, these factors had been implied by the respondents as part of risk allocation. For instance, respondent E stated that there was a need to allocate risks or manage safety issues upfront so that when problems occurred they could be resolved easily. Respondents C and D conceived disputes and arbitration as components of risk allocation as they pointed out the disadvantages of traditional lump sum procurement when disputes occur. They also advocated that design and build approaches favoured clients during the disputes and arbitration processes as all the risks would have been transferred to the contractor.

SUBJECTIVITY OF PROCUREMENT SELECTION CRITERIA

Respondents were asked to express their perceptions on the subjectivity of the decision criteria identified, and the results are summarised in Table 4.

Four out of five respondents believed that time certainty and price certainty could be measured objectively. Time certainty was unequivocal as the completion date could be reasonably predicted by measuring the job requirements. Likewise, price certainty was considered as an objective criterion as price can also be reasonably predicted beforehand. The certainty of price can then be

measured against the contractor's requirements.

All respondents believed that other selection criteria including speed, complexity, flexibility, responsibility, quality level, risk allocation and price competition were vague and subjective. These findings have supported some researcher's assertions (e.g. Rowlinson and McDermott, 1999; Cheung et al., 2001) that some procurement selection criteria are intangible in nature.

Speed

Respondent D claimed that speed was an arbitrary factor, which depended very much on the client's situations. The speed to be specified depends on the level of extra premium a client is prepared to pay for speeding up the design and construction processes. The definition of high speed may therefore differ from one client to another. Respondent B suggested that speed might be determined by contractor's experience. A contractor with ample experience in the prospective project type and construction method may complete the work in a much quicker time. As a result, the level of speed as specified by the client may not totally correspond to what the contractor can offer.

Complexity

All respondents believed that complexity was very difficult to define, and the definition usually varied from person to person. Respondent C suggested that the opposite of complexity was routine, repetitiveness or standardisation. As a result, a project could be very simple for someone who has done a similar job before, but extremely complex for someone with no prior experience of the project type. According to respondent A, complexity was vague as, apart from the complexity of physical design and work method statements, complexity could be caused by the public and/or people involved, and these are rather difficult to predict. The views of respondent A concur with those of Turner (1990) who claimed that complexity was a non-quantifiable criterion since it could not be clearly depicted in the specification.

Flexibility

All respondents conceived flexibility to be subjective. A good explanation was provided by respondent B who claimed that, in a construction project, flexibility depends on human factors such as stakeholders' situation, experience and competence, and non-human factors such as project type, project situations, external factors (weather, strikes, political impact). He added that as both human and non-human factors are unpredictable and very difficult to manage, flexibility could become relatively ambiguous to the decision-makers.

Quality

All respondents shared the same view that quality could be difficult to measure objectively, as it was partially determined by vague standards such as form, commodity, delight, and comfort. Turner (1990) claimed that the quality of the design concept may not be easily determined in the specification, and may sometimes involve expert opinions.

Responsibility

Responsibility was not considered to be objective since there is no fixed definition as to what is a high, medium or low level of client involvement in a project, instead the level of responsibility varies from project to project. Respondent C claimed that it was a normal practice to get actively involved in a project for as much as 50% of the total project time to gain the best results for the project. On the other hand, respondent A believed that allocating 50% of his total time to a project would be rather high.

Risk allocation

Four out of five respondents indicated that an interlacing relationship exists between risk allocation and responsibility, as the more responsibility one has been assigned in a construction project, the more risk one would have to assume. Not only did they think that responsibility was not fully structured, they also believed risk allocation could not be measured objectively. Respondent E elaborated by saying that when he transfers 50% of the total risk that might occur in a project to the contractor, he regards that amount of risk transfer as a high risk allocation and feels safe. On the other hand, a client who does not have any experience or knowledge in construction might think that it is necessary to transfer up to 90% of risk (i.e. a high risk allocation) to the contractor in order to feel comfortable.

Table 5: Procurement selection methods

Methods	Authors
Operational Research	
Procurement path decision chart	NEDO (1985)
Procurement rating system	Franks (1990)
Multi-attribute approach	Singh (1990) Bennett and Grice (1990) Ambrose and Tucker (1999)
Weighted score model	Griffith and Headley (1997)
Analytical hierarchy process	Alhazmi and McCaffer (2000)
Multi-attribute utility approach	Cheung et al. (2001)
Statistical	
Discriminant approach	Skitmore and Marsden (1988)
Computerised	
Rule-based expert computer system (ELSIE)	Brandon et al. (1988)

Price competition

The respondents believed that price competition was vague, as the definitions of low or high price competition would vary with different clients. Respondent A regarded a saving of 10% of the originally estimated project sum due to competitive tendering activities as high price competition, while respondent E indicated that he expected up to 20% saving to qualify as high price competition. Respondent B suggested that around 15% could be reasonably seen as high price competition.

DISCUSSION

Over the last two decades several theoretical selection models have been introduced with the aim of improving the objectiveness of procurement selection. These methods can be classified into three main categories, namely operational research, statistical and computerised models (Table 5).

While these models provide the means to improve the decision process, they fail to address the subjective characteristics of certain procurement selection criteria, which are used as primary input in these models. In fact, subjective criteria are usually linguistic in nature, which may contain a certain level of vagueness (fuzziness) in the description of semantic meanings (Zimmermann, 1991). Consequently these criteria may not be adequately handled by traditional probability theory, which assumes a precise definition of the situations to be dealt with (Kolmogoroff, 1956). Since probability theory is adopted in some procurement selection methods, there is a possibility that those methods may not properly capture the vagueness of the selection criteria used, and the decisions derived by these methods may be prone to error.

To illustrate the effects of misinterpreting a subjective criterion in the assessment process, an example based upon Skitmore and Marsden's multi-attribute approach is provided here. Assuming "complexity" as the only subjective criterion involved in the assessment, as a principle of probability theory, the client needs to select a priority rating scale (say from 1 to 20) to represent his/her perception on how complex the project would be. To reflect his/her perception on a highly complex project, the client may select a priority scale of, for instance, 15, 17, 20 or any other large number within the range. Tables 6 and 7 illustrate the preferred procurement options based on a priority scale for "complexity" of 17 and 20 respectively. With other selection criteria being equal, a different perception on "high complexity" could yield very different results. In this example, Procurement System E was the most preferred option should "high complexity" be interpreted as 17 (Table 6), while Procurement System B should be chosen if a priority scale of 20 was used (Table 7). As a result, the client may end up with different recommendations if there were different interpretations of the meaning of "high complexity".

Table 6: Result of procurement selection when priority rating for “high complexity” is 17

Client's priority criteria	Client's priority rating	Rationalise priority rating	Procurement paths													
			A		B		C		D		E		F		G	
			Utility result factor		Utility result factor		Utility result factor		Utility result factor		Utility result factor		Utility result factor		Utility result factor	
Speed	11	0.14	40	5.4	10	1.4	60	8.1	100	13.6	90	12.2	110	14.9	110	14.9
Certainty	12	0.15	30	4.4	30	4.4	70	10.4	100	14.8	100	14.8	10	1.5	110	16.3
Flexibility	5	0.06	110	6.8	110	6.8	40	2.5	40	2.5	40	2.5	90	5.6	10	0.6
Quality level	14	0.17	110	19.0	110	19.0	40	13.8	40	6.9	40	6.9	90	15.6	20	3.5
Complexity	17	0.21	100	21.0	100	21.0	50	14.7	50	10.5	50	10.5	110	23.1	20	4.2
Responsibility	12	0.15	30	4.4	30	4.4	100	10.4	100	14.8	100	14.8	10	1.5	110	16.3
Price competition	10	0.12	20	2.5	110	13.6	10	9.9	10	1.2	80	9.9	40	4.9	30	3.7
Totals	81	1.00		63.6		70.6		69.8		64.3		71.6		67.0		59.5
Rank order				6		2		3		5		1		4		7

Table 7: Result of procurement selection when priority rating for “high complexity” is 20

Client's priority criteria	Client's priority rating	Rationalise priority rating	Procurement paths													
			A		B		C		D		E		F		G	
			Utility result factor		Utility result factor		Utility result factor		Utility result factor		Utility result factor		Utility result factor		Utility result factor	
Speed	11	0.13	40	5.2	10	1.3	60	7.9	100	13.1	90	11.8	110	14.4	110	14.4
Certainty	12	0.14	30	4.3	30	4.3	70	10.0	100	14.3	100	14.3	10	1.4	110	15.7
Flexibility	5	0.06	110	6.5	110	6.5	40	2.4	40	2.4	40	2.4	90	5.4	10	0.6
Quality level	14	0.17	110	18.3	110	18.30	80	13.3	40	6.7	40	6.7	90	15.0	20	3.3
Complexity	20	0.24	100	23.8	100	23.8	70	16.7	50	11.9	50	11.9	110	26.2	20	4.8
Responsibility	12	0.14	30	4.3	30	4.3	70	10.0	100	14.3	100	14.3	10	1.4	110	15.7
Price competition	10	0.12	20	2.4	110	13.1	80	9.5	10	1.2	80	9.5	40	4.8	30	3.6
Totals	84	1.00		64.9		71.7		69.8		63.8		70.8		68.6		58.1
Rank order				5		1		3		6		2		4		7

CONCLUSION

The selection and use of an appropriate procurement system is crucial to project success. This paper aims to improve our understanding of the commonly used procurement selection criteria and the objectiveness of those criteria. The results indicate that there are nine procurement selection criteria commonly used by Australian clients: speed, time certainty, price certainty, complexity, flexibility, responsibility, quality level, risk allocation and price competition.

Only time certainty and price certainty were seen by the respondents as unambiguous criteria, as the completion date and price can be objectively predicted by the client beforehand. However, the other seven were regarded by the experts as subjective. An example has been presented to illustrate the effects of misinterpreting "high complexity" in a multi-attribute procurement selection model. The results indicate that different perceptions, as reflected by various priority ratings, would yield different recommendations for procurement system. This clearly does not improve the objectiveness of procurement system selection.

The requirements for linguistic input for some criteria justify the use of the fuzzy set theory (Zadeh, 1965). Fuzzy set theory is the key to decision-making when encountering vague conceptual phenomena. It has been applied to various construction management decision models involving the use of vague input variables, such as project scheduling (Ayyub and Haldar, 1984; Lorterapong and Moselhi, 1996), tender evaluation (Nguyen, 1984), contractor evaluation (Russell, 1992), and prediction of contractor failure (Russell and Jaselskis, 1993). Research into the application of fuzzy set theory to construction procurement selection is being conducted by the authors, and the results of this study will be reported when they become available.

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