

STUDYING THE REVERSE AUCTION BIDDING GAME FOR THE ROLE  
VARIANTS OF GUARDIANS IN THE FACILITIES MANAGEMENT INDUSTRY

A Thesis

by

APURVA KRISHNA GUPTA

Submitted to the Office of Graduate Studies of  
Texas A&M University  
in partial fulfillment of the requirements for the degree of  
MASTER OF SCIENCE

August 2010

Major Subject: Construction Management

Studying the Reverse Auction Bidding Game for the Role Variants of Guardians in the  
Facilities Management Industry

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Approved by:

Chair of Committee,	John Morgan Nichols
Committee Members,	Mardelle Shepley
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## ABSTRACT

Studying the Reverse Auction Bidding Game for the Role Variants of Guardians in the  
Facilities Management Industry. (August 2010)

Apurva Krishna Gupta, B.E., Bharati Vidyapeeth University,

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Reverse Auction Bidding (RAB) study into the construction industry commenced at Texas A&M (TAMU) University in 2004 from the work of a graduate student who was interested in the reasons for RAB being considered unethical by some. This thesis is the eleventh study into Reverse Auction Bidding building on the work of the previous researchers. Previous case studies investigated a number of different competitive situations ranging from three to ten players. In the last few studies, the bidding behavior and performance of participants in the RAB process is being observed with respect to their personality. Personality for each player is tested using the Keirsey Temperament Sorter (KTS) test. The KTS describes four major personalities and four role variants in each of the personalities, summing up to sixteen role variants. There appears at this stage a strong correlation between personality type and game performance. This study extends the work on the Guardian personality type to investigate the four sub-types of this personality. This study builds on the previous work by analyzing the four different Guardian role variants being Provider, Protector, Inspector and Supervisor. The aim of

the research is to investigate whether there is a difference in game returns between the personality type from within this group.

The study involves a game scenario involving a facility manager hiring the contractors who submit the lowest bid for the assumed renovation project. The study also gives the contractor a modified KTS questionnaire that can be used by them for hiring an individual for the position of an estimator with a competent personality.

The individuals were selected from undergraduate Construction Science students with limited experience. The game lasted for nine rounds, with the statistical results of the bidding and contract data showing patterns similar to the previous studies. The results show us that the individuals with a role variant of Providers provided the highest return in this case study, although a single case study is insufficient to draw formal conclusions on this matter, the result points to future research.

DEDICATION

To my mother

## ACKNOWLEDGEMENTS

I would like to thank my chair, Dr. John Nichols, for being my guide, teacher and idol. I would also like to thank my committee members, Dr. Nancy Holland and Dr. Mardelle Shepley, for all their help and support in this journey.

I would also like to thank my father for supporting me. My friends and my sister have always strengthened me in this endeavor. I strongly appreciate the help of my friend Yaquta Faquih, without whom this thesis could not be completed.

## NOMENCLATURE

ASP	Application Service Provider
KTS	Keirsev Temperament Sorter
RAB	Reverse Auction Bidding
SQL	Sequential Query Language
TAMU	Texas A&M University



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## CHAPTER I

### INTRODUCTION

#### BACKGROUND TO THE STUDY

McAfee and McMillan (1987) defined auction as “explicit set of rules determining resource allocation and prices on the basis of bids from the market participants.” They noted auction theory deals with price setting mechanisms for products that have no standard value. As the name implies, a reverse auction is the opposite of a traditional auction in which competition among buyers drives up the price until no one is willing to bid any higher (Fischbach 2005). The value of the reverse auction is that the vendors are able to either re-bid, or lower their bid multiple times.

This study presents a case study of a Reverse Auction Bidding game using a number of Guardian personality types to test for performance of the sub-types in a four player game.

Some purchasers consider Reverse Auction Bidding (RAB) systems coerce contractors to present their lowest bid. However, opponents of this strategy state that the construction industry cannot apply RAB, as the construction services are unique and subject to changes and thus should not be thought of as commodities (Thompson and Knoll 2002). Some researchers postulate that RAB reduces contractor profit which in turn may compromise quality of the job and safety on the site (Angelo 2002).

However, comprehensive research at Texas A& M University (TAMU) provides some evidence that RAB can provide a reasonable return to shareholders and banks of

---

This thesis follows the style of *Adult Education Quarterly*.

the contractors, albeit with the strain of the bidding system perhaps interfering with the development of the contractor to purchaser relationship (van Vleet 2004).

Van Vleet (2004) initiated the ongoing Reverse Auction Bidding Study at TAMU. This long-term study has developed from a single case study, completed by van Vleet, to a series of case studies, now combined with personality testing of all participants.

Van Vleet had Kim (2004) develop a Microsoft Access database system and Application Service Provider (ASP) web based user interface for the study. He analyzed and partly answered questions as to the technical merits of this bidding system and as to the ethical and legal questions raised with the obvious tacit collusion that arises (Nichols 2010). His research uses a case study to examine the behaviors developed within the bidding game, specifically the strategies developed by the bidders with the lowest overall return and the highest overall returns, and an analysis of the average distribution of returns.

It was observed that the RAB game was played with different strategies by different bidders (Gregory 2006). Panchal (2007) identified three different classifications of bidders as:

- i. Economic winner – One who generates the highest average job price
- ii. Economic loser – One who generates the lowest average job price
- iii. Average bidder – Bidder with average returns

Chouhan (2009) measured and filtered the personality types with the help of Keirsey Temperament Sorter (KTS), categorized the above classification into:



- i. Economically effective bidder
- ii. Economically ineffective bidder
- iii. Members generating average distribution returns

Chouhan (2009) categorized the personalities of Administrator (STJ) as the economically effective bidders and the personalities of Conservator (SFJ) as the economically ineffective bidders. Guhya (2010) extended this theory defining a series of games within the RAB system.

Saigaonkar (2010) reinforced this research observation by showing that out of the four primary personalities according to the KTS the Guardians gave a better performance than the other three personality types in a controlled game. This observation is in no way proven, but the evidence suggests that the guardians will win in a game.

This research tests the four sub-type personalities of Guardians and identifies the characteristics of the bidders. The research also portrays the learning skills of the various personalities tested, such that the highest profit can be gained. As always this is an ongoing research study, the next stages are to repeat the work to confirm the observations.

## PROBLEM STATEMENT

This research is carried out to provide support for the hypothesis that the personality type Guardian can be further divided to identify the economically effective bidder.

## SUB-PROBLEMS

The sub-problems are:

- i. Does the bidders' personality affect the strategy used by the player in the RAB game?
- ii. Does the learning pattern of bidders differ with due course of time?
- iii. Which role variant of the Guardian personality provides the maximum profit?

## LIMITATIONS

The limitations of the study are:

- i. All bidders are students in the Department of Construction Science at TAMU and have no prior experience of RAB.
- ii. The research does not take into consideration any typing errors or miscalculations caused by the participant during the course of the game.
- iii. The research was performed in a controlled setting which limits the existing variables and avoids the risks that are faced in the construction industry.

## STUDY SIGNIFICANCE

The rising competition in the facilities management field is evident. The strategies of the buyers, contractors and subcontractors have to be revised frequently to suit the current needs. This research would help the facility management staff to identify the appropriate personality during the bidding process, which can be further used to gain maximum profits.

## CHAPTER II

### LITERATURE REVIEW

#### INTRODUCTION

The research is divided into four detailed reviews namely definitions of the game, the reverse auction bidding process, the personality testing and the analysis of the game.

#### DEFINITIONS

Guhya (2010) provided a comprehensive set of definitions that are strictly relevant to the reverse auction bidding system applied at Texas A& M University System. These definitions are:

*Reverse Auction Bidding:* Single or multiple-item, open, descending-price auction. The initiator specifies the opening bid price and bid decrement. Each bidder submits a successively lower bid. At the end of the auction, the bidders with the lowest bids win (van Vleet 2004).

*Game Theory:* A formal analysis of conflict and cooperation among intelligent and rational decision makers (van Vleet 2004).

*Collusion:* A secret agreement between two or more parties for a fraudulent, illegal, or deceitful purpose (van Vleet 2004).

*Bidders Personality:* “The dictionary defines personality in several ways. One definition emphasizes the public, social stimulus, or behavioral characteristics of a person that are visible to other people and make an impression on them. Another definition stresses a person’s private, central, inner core. Included within this private

core are the motives, attitudes, interests, beliefs, fantasies, cognitive styles and other mental processes of an individual. Some definitions of personality emphasize its “person” quality, personal existence, or identity features. Other meanings of personality are associated with specific disciplines or professions” (Panchal 2007).

*Responsive Bidder:* A bidder whose bid satisfies all the terms and conditions of bidding, delivery requirements, detailed specifications is called responsive bidder.

*Aggressive Bidder:* Aggressive bidders are the bidders who attain highest overall returns in the entire bidding process (Chouhan 2009).

*Average Bidder:* Average bidders are bidders who attain average distribution of returns in the entire bidding process (Chouhan 2009).

*Success Rate:* It is a ratio of number of bids won by a bidder to total number of bids made by that particular bidder.

*Bidding Aggression:* It is a ratio of total number of bids made by an individual bidder to total number of bids made by all the bidders in the reverse auction bidding pool.

*Bidder:* An entity that submits bid. In this game, there are usually three to ten bidders.

## PERSONALITY TESTING

According to Rogers (2010), the KTS test is a good technique to test the temperaments of various players. This type of temperament sorter has 70 different questions.

Table 1 lists the different personality types and defines four main personalities designated as follows:

- i. Idealist (NF)
- ii. Rational (NT)
- iii. Guardian (SJ)
- iv. Artisan (SP)

Table 1

*KTS Different Personality Types*

	Temperament	Role	Role Variant
Introspective (N)	Idealist (NF) <i>Diplomatic</i>	Mentor (NFJ) <i>Developing</i>	Teacher (ENFJ): <i>Educating</i>
		Advocate (NFP) <i>Mediating</i>	Counselor (INFJ): <i>Guiding</i>
	Rational (NT) <i>Strategic</i>	Coordinator (NTJ) <i>Arranging</i>	Champion (ENFP): <i>Motivating</i>
		Engineer (NTP) <i>Constructing</i>	Healer (INFP): <i>Conciliating</i>
			Field marshal (ENTJ): <i>Mobilizing</i>
			Mastermind (INTJ): <i>Entailing</i>
Observant (S)	Guardian (SJ) <i>Logistical</i>	Administrator (STJ) <i>Regulating</i>	Inventor (ENTP): <i>Devising</i>
		Conservator (SFJ) <i>Supporting</i>	Architect (INTP): <i>Designing</i>
	Artisan (SP) <i>Tactical</i>	Operator (STP) <i>Expediting</i>	Supervisor (ESTJ): <i>Enforcing</i>
		Entertainer (SFP) <i>Improvising</i>	Inspector (ISTJ): <i>Certifying</i>
			Provider (ESFJ): <i>Supplying</i>
			Protector (ISFJ): <i>Securing</i>
		Promoter (ESTP): <i>Persuading</i>	
		Crafter (ISTP): <i>Instrumenting</i>	
		Performer (ESFP): <i>Demonstrating</i>	
		Composer (ISFP): <i>Synthesizing</i>	

Table 2 provides a descriptive meaning of each letter, which in combination describes the characteristics of each unique personality.

Table 2

*Summary of Individual Components of the Different Personality Types*

Letter	Name	Meaning
E	Extraversion	Feel motivated by interaction with people. Tend to enjoy a wide circle of acquaintances, and <i>gain</i> energy in social situations
N	Intuition	More abstract than concrete. Focus attention on the big picture rather than the details, and on future possibilities rather than immediate realities
F	Feeling	Value personal considerations above objective criteria. When making decisions, often give more weight to social implications than to logic
J	Judgment	Plan activities and make decisions early. Derive a sense of control through predictability
I	Introversion	Quiet and reserved. Generally prefer interacting with a few close friends rather than a wide circle of acquaintances, and <i>expend</i> energy in social situations
P	Perception	Withhold judgment and delay important decisions, preferring to "keep their options open" should circumstances change
T	Thinking	Value objective criteria above personal preference. When making decisions, generally give more weight to logic than to social considerations
S	Sensing	More concrete than abstract. Focus attention on the details rather than the big picture, and on immediate realities rather than future possibilities

The different temperaments and the characters of different personalities were pointed out from Keirsey's book Please Understand Me by Buenger (2008) as part of a study into personality at work. Buenger provided information of the positive and negative aspects of the bidders with different personality types.

Keirsey and Bates (1978) categorized four recognizable temperaments and named each of them to the best suited Greek mythological figure:

- i. Apollo – reach for the sky (NF),
- ii. Prometheus – foresight (NT),
- iii. Epimetheus – hindsight (SJ)
- iv. Dionysius – let’s drink wine (SP).

Keirsey in 1998 performed a systematic analysis based on interests, orientation, values, introspection and social roles, and changed the personality types as provided in Table 1.

Berens and Cooper (2001) describes the four primary personalities:

- i. Artisans are observant and practical with notable skill set in crafting, performing and composing. Their highest strength is in tactical variation.
- ii. Guardians are observant and supportive who are concerned with responsibility and duty and excel at facilitating, checking and organizing.
- iii. Idealists are introspective and cooperative. They seek their own unique identity and are notable for their diplomatic intelligence. They have a high skill value in inspiring, clarifying and individualizing.
- iv. Rational are introspective and pragmatic. They seek self-control and are deeply concerned with their own knowledge and have a high strength in strategic intelligence. Their personality type is known to excel in logical investigation, conceptualizing and coordinating.

Berens and Cooper (2001) also noted that guardians are concrete and cooperative in pursuing their goals and have a high strength in logistics. Tieger and Tieger (1999) identified the guardians as valuable team members who are committed to preservation of the social institutions and have a special interest in ensuring that all contingencies in a work are considered.

Keirsey (1998) further divided the guardians into four different role variants:

i. Supervisor (ESTJ)

These are the individuals who are dedicated to a smooth running society. They strongly believe in rules and procedures and prefer to take the road trodden before. They are faithful, frank and hardworking.

ii. Inspector (ISTJ)

They are known to keep their word and their high intention on preserving social values. Professionally, they are quiet and serious. They perform their duties with dedication and they have built a reputation for consistent performance. They are also known to use their past experiences in making decisions.

iii. Provider (ESFJ)

They are known to be nurturers and thus they have a high talent in providing friendly social service. They are known to be highly cooperative and thus are remarkable team members. Professionally, they are skilled in public relations.

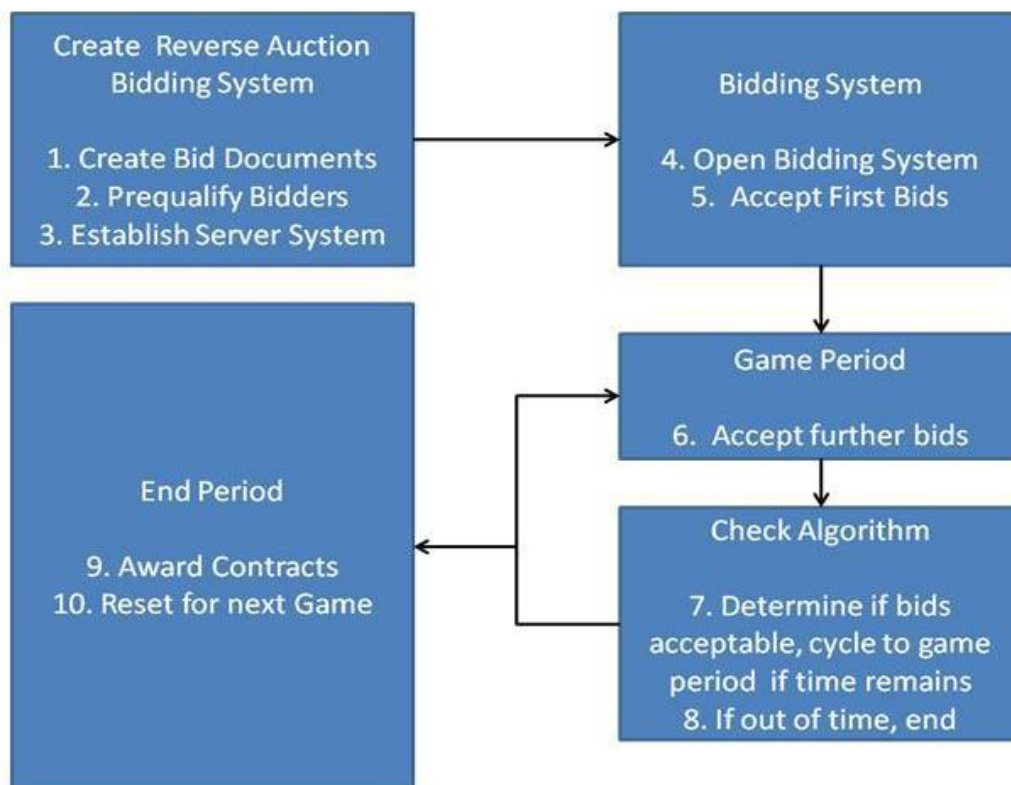
iv. Protector (ISFJ)



These individuals have an affinity to be informative and attentive. They are usually strong in work ethics and take care that a routine is followed. They are known to be frugal and thus they take special concern over the waste of any resources.

#### REVERSE AUCTION BIDDING SYSTEM

Figure 1 shows the typical procedure for the reverse auction system. The process is continuous and in some cases the total bidding period is set to 15 minutes for practical reasons.



**Figure 1.** RAB General Algorithm (after Guhya, 2010)

RAB is an accepted tool among buyers and suppliers for electronic conciliations (Richard and Elena 2006). It is noted that the RAB disturbs the association between the owner and the buyer. It is also known to decrease the quality of the product and increase the product delivery time. However, this observation does not necessarily hold true and requires further validation (Horlen, Eldin et al. 2005).

Chouhan (2009) assumed that 95% of the people interviewed by Jap (2007) had the opinion that RAB can further deter the relationship between the supplier and the buyer. However, Jap (2007) had reported that 5% of the people interviewed opined that RAB improves upon the same. Thus this assumption can be misinterpreted as 95% who were believed to have a converse opinion of the RAB game may in part have actually thought that there would be no change in the professional relationship.

Literature also suggests that the bidders' behavior also helps the bidder in gaining a strategic position, thus helping the buyer in gaining economic returns (Engelbrecht and Wiggans 2007).

Jap (2007) has conducted a comprehensive research on RAB and its relation to the aggressiveness of the bidder. The factors that were considered by him were the number of bids, the rate of bidding and degree of price reduction. The conclusions of his work were:

- i. The suppliers who have the knack of developing an enduring relationship with the buyer submits less number of bids at greater intervals and minimizes the reduction in the profit margins. This also depends on the Herfindahl index of the bidding situation (van Vleet 2004).

- ii. Suppliers who were more aggressive and submitted more number of bids with a maximized reduction in the profit margin have a lower importance of the association with the buyer after the auction. This type of personality was related by Nichols (2010) to the lost money in the bidding.

Jap (2007) concluded “Strategic bidding behavior of suppliers in which they appear to trade off potential, economic and rational investments is long-term exchange with short-term pricing concessions.”The other notable conclusions were:

- i. With the increase in the number of bidders, suppliers tend to lose interest in the RAB process. Nichols (2009) bolstered this conclusion by commenting that the aggressiveness of the bids would decrease when compared to the cost of doing business if the number of bidders is excessive.
- ii. Bidders become skeptical of the attendance of the non-qualified bidders in the process.

Staw (1976) has acknowledged that “Bidding aggressiveness in response to the total number of bids by others may represent a psychological escalation of commitment.”This behavior was also observed in current set of studies performed by Guhya (2010), Peterson (2010) and Saigaonkar (2010).

The negative emotional state of the bidders induces the tendency to increase the frequency of bidding, thus increasing the number of bids made in the process. However, no such change has been suggested with the positive frame of mind (Bosman and Riedl, 2004). They also have concluded that the bidder’s behavior should be taken into account

during the time of bidding and people with negative emotions can increase the risk behavior in the bidding process. Raghunathan and Phan ((1999)) also postulated that emotionally depressed individuals opt for “High risk – high reward option” and anxious individuals vice-versa. The people with positive emotions take less risk when the stakes are high (Isen and Patrick 1983; Isen and Geva 1987).

This was again proved by Loewenstein et al. (2001)) who said that the negative emotional state induces pessimistic choices. Chouhan (2009) observed the difference among the aggressive and average bidders and Chaudary (2009) and Saigaonkar (2010) proposed that this may be due in part to personality types.

## CHAPTER III

### METHODOLOGY

#### INTRODUCTION

The research method has been outlined into two distinct sections namely the game set up and the data collection.

#### GAME SETUP

##### INTRODUCTION

The bidding period is set for 15 minutes with practical experimental reasons taken into account. A five minute break between each game is provided to the bidders. In the game, the bidders are selected on the basis of their personality types and are competed against each other to gain businesses.

An initial amount of \$40,000 is provided to the bidders. To make the scenarios realistic, variables such as rain delay, travel and delivery charges, delays due to distant projects are also provided. The aim of the game is to generate maximum profit.

The simulation contains a set of instructions provided to the bidders (participants) in the game process. It includes the details related to the project, description, and variables that affect the project as well as its duration:

- i. The total duration of the game will be a maximum of nine consecutive weeks.
- ii. All bidders initially have an equal dollar amount of \$40,000 available in their bank accounts.

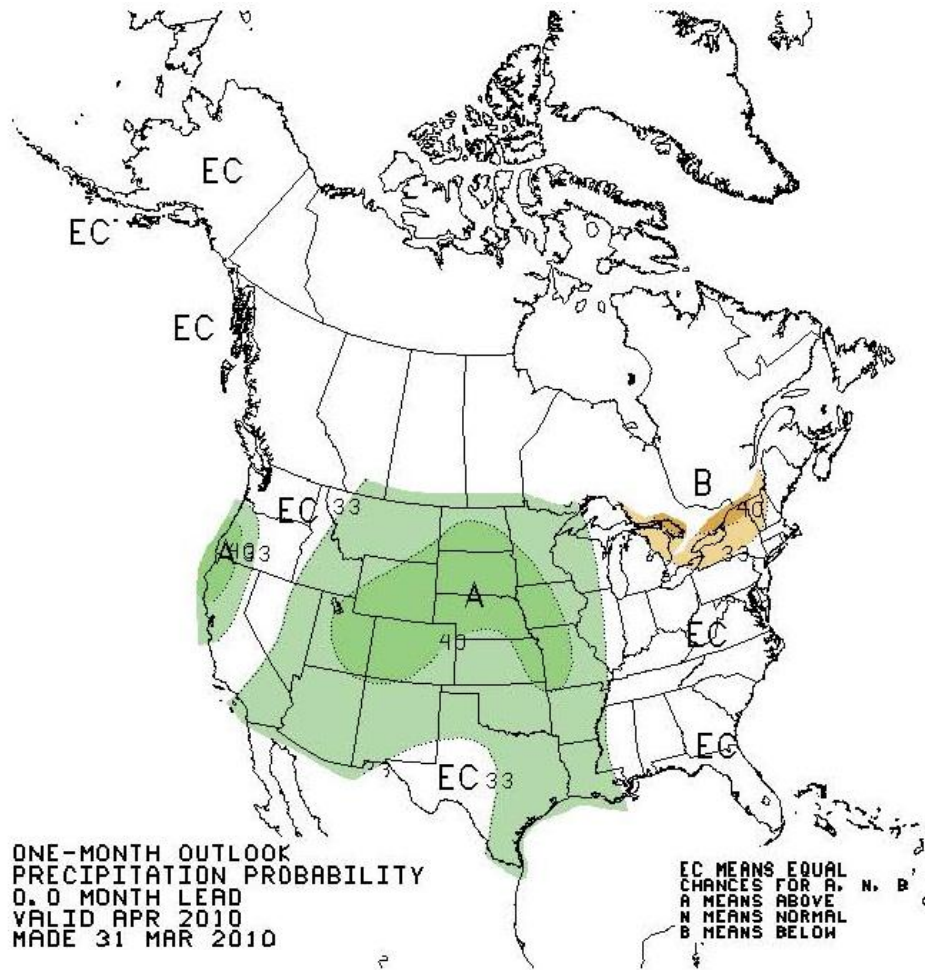
- iii. The original cost for every job was estimated to be \$10,000 by a competent estimator (van Vleet, 2004). The travel costs and the delivery charges change with the location. The values of these costs are posted along the job site address.
- iv. The duration of completing every job is assumed to be five days, excluding the rain delay.
- v. The work week is assumed to be five days long.
- vi. Initially, every bidder would only be allowed to work on three jobs in a week.
- vii. If a bidder decides to undertake more than three jobs in a week, then the bidder would have to take a loan from the bank. The additional charge for each loan is \$500 and this would be automatically charged irrespective of the fact that they have won the bid or not.
- viii. Assuming the base cost to be \$10,000 and the duration being five days, each bidder gets a chance of making \$2,000 per day. The travel expenses and the delivery charges would also be summed up on a daily basis accordingly.
- ix. The location of the owner is assumed to be located in Sugar Land, Texas and thus the additional expenses for travel and delivery are assumed on the basis of the proximity of the job site from this place. The offices of the subcontractors are also assumed to be in Sugar Land, Texas.

- x. The construction industry standards have accepted the minimum return on investment to be 10%. However, this would not be tested during the game and the players would be cautioned of this condition.
- xi. The bidder would get the payment for the work completed on the fifth day of construction.
- xii. The primary objective of all the bidders is to increase their profits while maintaining bank assurance and satisfactory liquidity.

#### RAIN DELAY

The notion of the game takes into account the climatic conditions of Houston. Houston has significant amount of rainfall in the months of May, June and July and the game is assumed to be played in these months. A conservative situation that the subcontractor will have work available during any rain delay is adopted and thus no additional charges will be incurred for any delays.

National Oceanic and Atmospheric Administration (NOAA 2010) provides s with the statistical information for the likelihood of rain in the Houston area. It also specifies that this area has approximately 33% chance of rains in this period. This probability is accounted for in the game to develop the rain delay vector. Thus the game has a 33% probability of delay on whichever given day. Figure 2 depicts the rain distribution for this area and has been used in several previous studies (van Vleet 2004; Chouhan 2009; Petersen 2010; Saigaonkar 2010).



**Figure 2.** Rain Probability in USA (after NOAA, 2010)

The factor of rain delay would affect the bidding as delays would increase the external costs (travel and delivery charges) and on a whole the construction cost of a job. The bidder can take one of the calculated alternatives to acquire a bank loan and can compensate for the lost day by the bank charge of \$5,500. The minimum capacity of a bidder would reduce to only two additional jobs for a week in which there is an



incomplete job. As all the jobs are assumed to finish in five days, any job incurring a rain delay is called an incomplete job.

Table 3 shows the rain delay with the respective site locations on a given day. A “1” designates sufficient rainfall that would cause a delay and a “0” designates no rainfall. As of now there is no relation between the site locations and the amount of rainfall they receive, however, this anomaly is being improved upon and would be available to future researchers.

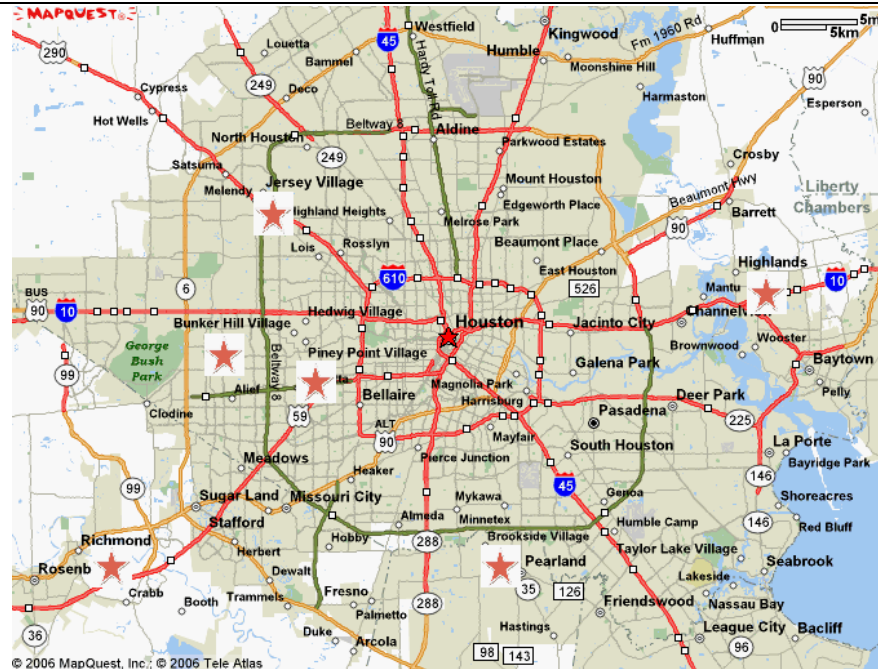
Table 3

*Rain Delays for Week One*

Day	Site					
	One	Two	Three	Four	Five	Six
Monday	1	0	0	0	1	0
Tuesday	0	1	1	0	0	0
Wednesday	0	0	0	0	0	0
Thursday	0	0	1	0	0	1
Friday	1	0	0	0	1	1
Saturday	0	0	0	0	0	0

## SITE LOCATIONS

Van Vleet (2004) developed the RAB game and located six work sites around Sugar Land, Texas. Figure 3 depicts these locations with a star.



**Figure 3.** Construction Site Locations in Houston (after MapQuest 2006)

The six construction sites selected by van Vleet (2004) were Brookside village, Piney Point village, Highlands, Jersey village, Bunker Hill village and Richmond. The external expenses of travel and delivery are directly proportional to the distance of these site locations from Sugar Land, Texas (owner's office). The game theory explained by Guhya (2010) is not repeated here as this has been unchanged in terms of scope for this game. All the jobs in the consecutive 15 minute period are shown to be repetitive in the game and thus the scope of the game remains unaltered from week to week. This has

also been kept unaltered to maintain the simplicity such that every bidder understands the game properly. The use of the same scenario is established merely to guide the participant to the assumption that the market pattern follows the similar work type.

Table 4 states the location of the site and its distance for the owner's office (Sugar Land, Texas).

Table 4

*Location of the Construction Sites in Houston*

Site #	Location of Development	Distance from Sugar Land (kilometres)
1	Brookside Village	41.6
2	Piney Point Village	24
3	Highlands	70.4
4	Jersey Village	40
5	Bunker Hill Village	27.2
6	Richmond	14.4

#### GAME SCENARIO

A Real Estate Investment Trust (REIT) located in Sugar Land acts as an owner who renovates the old buildings and sells them to various clients. The facilities manager, who is an employee in this REIT, is responsible for hiring contractors and sub-

contractors to carry out the renovation of the buildings. The contractors and sub-contractor are therefore asked to bid to acquire the project.

### GAME PLAY

The game was played with four participants who were selected as they had the desired role variants of Provider, Protector, Supervisor and Inspector in the personality type of Guardians.

The probability of two dice rolls was used to control the number of jobs that were offered each week. All the previous studies have also used the same randomness to control the number of jobs. The option of borrowing money from the bank at an additional charge is offered to each bidder and the program would ask the participants if they would like to do so.

### DATA COLLECTION

Van Vleet(2004) generated a website using Microsoft Access with the help of ASP programming (Kim 2004; Kingsley-Hughes, Kingsley-Hughes et al. 2004) This website runs the simulation of the RAB game and the data is collected to analyze the bidding behavior in the Microsoft Access database. The programming details are provided in the paper by Gregory (2006). While conducting similar research, Gregory (2006) encountered substantial problems when 10 bidders simultaneously tried to log in the same Microsoft Access database. This problem was solved by Wellington (Wellington 2006) when a Sequential Query Language (SQL) server was configured. The SQL server was hosted in TAMU's college of Architecture and every participant

was assigned with a unique username and password. The unique login username assumes four arbitrary company names which are:

- i. Driver Co.
- ii. Pliers Co.
- iii. Concrete Co.
- iv. Hammer Co.

These unique login names not only solved the problem but also allowed the researcher to gain access relevant information of each bidder. The information given to each bidder on the website included the cost of the job the current bids being placed by other users and their company name. No bidder was allowed to commence bidding before the starting time and the bidding automatically closed for five minutes after a period of 15 minutes. Figure 4 shows the “all current bids” which is provided to all the participants and is identical for all of them. This screen illustrates all the necessary information for the available jobs in that week. The separate columns on the screen allow the bidder to obtain all the information such as the current bid price, estimated profit and the name of the lowest bidder. This is the primary screen in which all the bids would be placed under the “my price” column.

Rob Van Vleet's Reverse Auction Bidding - ALL CURRENT BIDS [\[ALL CURRENT BIDS\]](#) [\[ALL COMPLETED JOBS\]](#) [\[MY BIDS INFO\]](#) [\[LOGOUT\]](#)

Now : Day56 (No more days), Experiment expired

Notice

- Click the job number or current price of active bids to check the bid history of each jobs !!!
- Remember your initial job capacity is only 3. You cannot bid anymore if your capacity is over.
- Refresh your browser or click [\[ALL CURRENT BIDS\]](#) button frequently during the bid time to check updated current bid prices.

All Current Bids											Next Bid started in min.	Below Bids finished in min.	
JOB#	LOCATION	TRAVEL COST	DELIVERY COST	ESTIMATED COST	CURRENT PRICE	Ept. Profit	Ept. Profit%	BIDDER	Bid Date	MY PRICE	SUBMIT		

\* "Ept." means "Expected".

**Figure 4.** All Current Bids Screen from RAB Web Site (Guhya,2010)

As explained in the previous sections, every bidder would be given a chance to take a bank loan at a fee of \$500, if the participant wants to exceed the available restriction. This would be shown on the “my bids info” page. This is depicted in Figure 5 which shows the offer of the bank loan.

Notice

- Click the job number or current price of active bids to check the bid history of each jobs.
- Remember your initial job capacity is only 3. You cannot bid anymore if your capacity is over, without taking out a loan at \$500 per site per contract.
- Refresh your browser or click [\[ALL CURRENT BIDS\]](#) button frequently during the bid time to check updated current bid prices.
- \* "Ept." means "Expected".
- Bids start on the 10, 30 and 50 minute times for **2106 jobs**. Bidding Time is 15 minutes.
- You have a clock, but remember your clock may be different to the server clock and you need to allow for this fact.
- The tab [\[MY BIDS INFO\]](#) can take 1:30 minutes to refresh. Be warned.

**Currently your capacity is full including current winning bids and jobs in progress.  
You cannot bid at this time.**

If you ask for a Bank Guarantee, you can increase your capacity. Bank Guarantee fee is \$500 per guarantee. Do you want?

**Figure 5.** Bank Guarantee Web Form (Guhya,2010)

Figure 6 shows the protocol of the reverse auction process. If a bidder tries to bid a higher amount than the current bid, then the screen shows a warning that it is not allowed to place a higher bid than the current lowest amount.

Notice

- Click the job number or current price of active bids to check the bid history of each jobs.
- Remember your initial job capacity is only 3. You cannot bid anymore if your capacity is over, without taking out a loan at \$500 per site per contract.
- Refresh your browser or click [\[ALL CURRENT BIDS\]](#) button frequently during the bid time to check updated current bid prices.
- \* "Ept." means "Expected".
- Bids start on the 10, 30 and 50 minute times for **2106 jobs**. Bidding Time is 15 minutes.
- You have a clock, but remember your clock may be different to the server clock and you need to allow for this fact.
- **The tab [\[MY BIDS INFO\]](#) can take 1:30 minutes to refresh. Be warned.**

**Your bid amount is higher than current lowest bid amount!!**

**Don't forget this is a reverse auction !!!!**

**Check the current bid amount and try again!!!**

**Figure 6.** Higher than Acceptable Bid Web Statement (Guhya, 2010)

At the end of 15 minutes the jobs would be awarded to the current lowest bidder for each respective job. Figure 7 shows “my jobs in progress” page which informs the bidder about the jobs won and the current jobs which are in progress.

Driver Co.'s Reverse Auction Bidding - MY BIDS' INFORMATION [\[ALL CURRENT BIDS\]](#) [\[ALL COMPLETED JOBS\]](#) [\[MY BIDS INFO\]](#) [\[LOGOUT\]](#)

Now: Day 22 (Monday), Week: 4

**My Active Bids**

JOB#	LOCATION	CURRENT PRICE	CURRENT BIDDER	TIME REMAINING	MY LOWEST BID AMOUNT	OUTBID
14	Woodlands	\$ 100000	Driver Co.	806 seconds.	\$ 100000	
15	Kingwood	\$ 100000	Driver Co.	806 seconds.	\$ 100000	

**My Jobs in Progress**

JOB#	LOCATION	Bid Amount	Job Start Date	Delays	Construction days	Cost to Date
8	Gleanloch farms	\$ 100000	Day 16	3 days	4 days	\$ 8600
9	Kingwood	\$ 100000	Day 16	3 days	4 days	\$ 8740
10	Sugarland	\$ 100000	Day 16	3 days	4 days	\$ 9200
11	Gleanloch farms	\$ 100000	Day 16	3 days	4 days	\$ 8600

**My Completed jobs**

Job#	Site	Bid Date	Bid Amount	Cost	Profit	Start day	End day	Rainy days	Profit Rate
5	Woodlands	Day 8	\$ 49999	\$ 11325	\$ 38674	Day 9	Day 15	Day 2	77.35%

My summary

- Current Spare Capacity For Additional Work : 2 [ Your total capacity : 6 (Initial capacity : 3, Added capacity by bank guarantee : 3)
- Current Financial Condition : \$ 41034 ( No money paid to initiate work, No money paid in middle of job)  
[ = Capital money [\$40000] + Profits from completed jobs - Costs of current jobs in progress - Bank Guarantee Fee(\$500/loan)]  
Current My Total Bank Guarantee Fee : \$ 2500

**Figure 7.** My Bid Info Web Page (Guhya,2010)

The participants are encouraged to visit the “my bids info” page to obtain the relevant information throughout the game process. The relevant information that assists the participants includes:

- i. The current jobs in progress which allows the participants to plan for future bids.
- ii. The participant can visit this page during the game process to obtain the information about the current bid placed and whether the participant has been outbid on that particular job. Thus this page describes the current status of the bidder with respect to other bidders.
- iii. The category of “my completed jobs” enlists all the completed jobs that the bidder has won during the course of the game.

The “my bids info” page also gives a chance to the participants to develop future strategies such as the number of bids that the participant can place in the next game. The current financial status of the bidder is also provided on this page under the category of “my summary”. Figure 8 shows the screenshot of the “Completed Jobs” screen which has the following information:

- i. The current cash assets.
- ii. Capacity of undertaking additional jobs including the jobs with bank guarantees.
- iii. The cumulative bank charges applied till date.
- iv. The current financial condition assists the participant with the liquidity available. It is calculated by using the formula given below. The initial capital available to each participant is \$40,000.

Current Financial Condition = (Capital + Profits) – (Costs of Current Jobs + Bank Costs)



Driver Co.'s Reverse Auction Bidding - ALL COMPLETED JOBS [\[ALL CURRENT BIDS\]](#) [\[ALL COMPLETED JOBS\]](#) [\[MY BIDS INFO\]](#) [\[LOGOUT\]](#)

Now: Day 56 (Monday), Week: 11

**My Completed jobs**

Job#	Site	Bid Date	Bid Amount	Cost	Profit	Start day	End day	Rainy days	Profit Rate
1	Pecan Grove	Day 1	\$ 50000	\$ 10725	\$ 39275	Day 2	Day 6	Day 0	78.55%
2	Gleanloch Farms	Day 1	\$ 50000	\$ 10950	\$ 39050	Day 2	Day 8	Day 2	78.10%
3	Pecan Grove	Day 1	\$ 50000	\$ 10725	\$ 39275	Day 2	Day 6	Day 0	78.55%
4	Woodlands	Day 1	\$ 50000	\$ 11325	\$ 38675	Day 2	Day 11	Day 5	77.35%
8	Gleanloch farms	Day 15	\$ 50000	\$ 10950	\$ 39050	Day 16	Day 24	Day 4	78.10%
9	Kingwood	Day 15	\$ 50000	\$ 11200	\$ 38800	Day 16	Day 24	Day 4	77.60%
10	Sugarland	Day 15	\$ 50000	\$ 11700	\$ 38300	Day 16	Day 24	Day 4	76.60%
11	Gleanloch farms	Day 15	\$ 50000	\$ 10950	\$ 39050	Day 16	Day 24	Day 4	78.10%
25	Sugarland	Day 42	\$ 50000	\$ 11700	\$ 38300	Day 44	Day 51	Day 3	76.60%
26	Pecan Grove	Day 42	\$ 50000	\$ 10725	\$ 39275	Day 44	Day 49	Day 1	78.55%
27	Sugarland	Day 42	\$ 50000	\$ 11700	\$ 38300	Day 44	Day 51	Day 3	76.60%

**Figure 8.** All Completed Jobs Screen (Guhya,2010)

## PERSONALITY TYPES

Each individual was surveyed using the standard questionnaire of the KTS test. The questionnaire comprises of 70 questions and each question has two choices of answers. The information in these choices characterizes the personality type of an individual. The game process compares these personality traits against the financial gains made in the game. The KTS theory states that it analyzes these 70 questions to understand the basic temperament of an individual and the individuals' long term behavioral pattern (Keirse, 1988). KTS also helps understand the individuals' interests, orientation, principles, introspective image and their role in the community.

## SUMMARY

The results of this research are provided in three stages.

- i. Personality testing
- ii. RAB game play
- iv. Analysis.

## CHAPTER IV

### RESULTS

#### INTRODUCTION

Figure 9 shows the procedure describing the selection of the participants. Out of the 26 participants surveyed there were 18 Guardians, two Rational, one Idealist and two Artisans. As the previous studies by Saigaonkar (2010), Peterson (2010), Machado (2009) and Chouhan (2009), it has already been confirmed that the Guardians have a better chance of winning the game. Thus the 18 Guardians were again sorted out to achieve the final four participants, each belonging to four different role variants namely, Provider, Protector, Supervisor and Inspector.

#### PERSONALITY TESTING

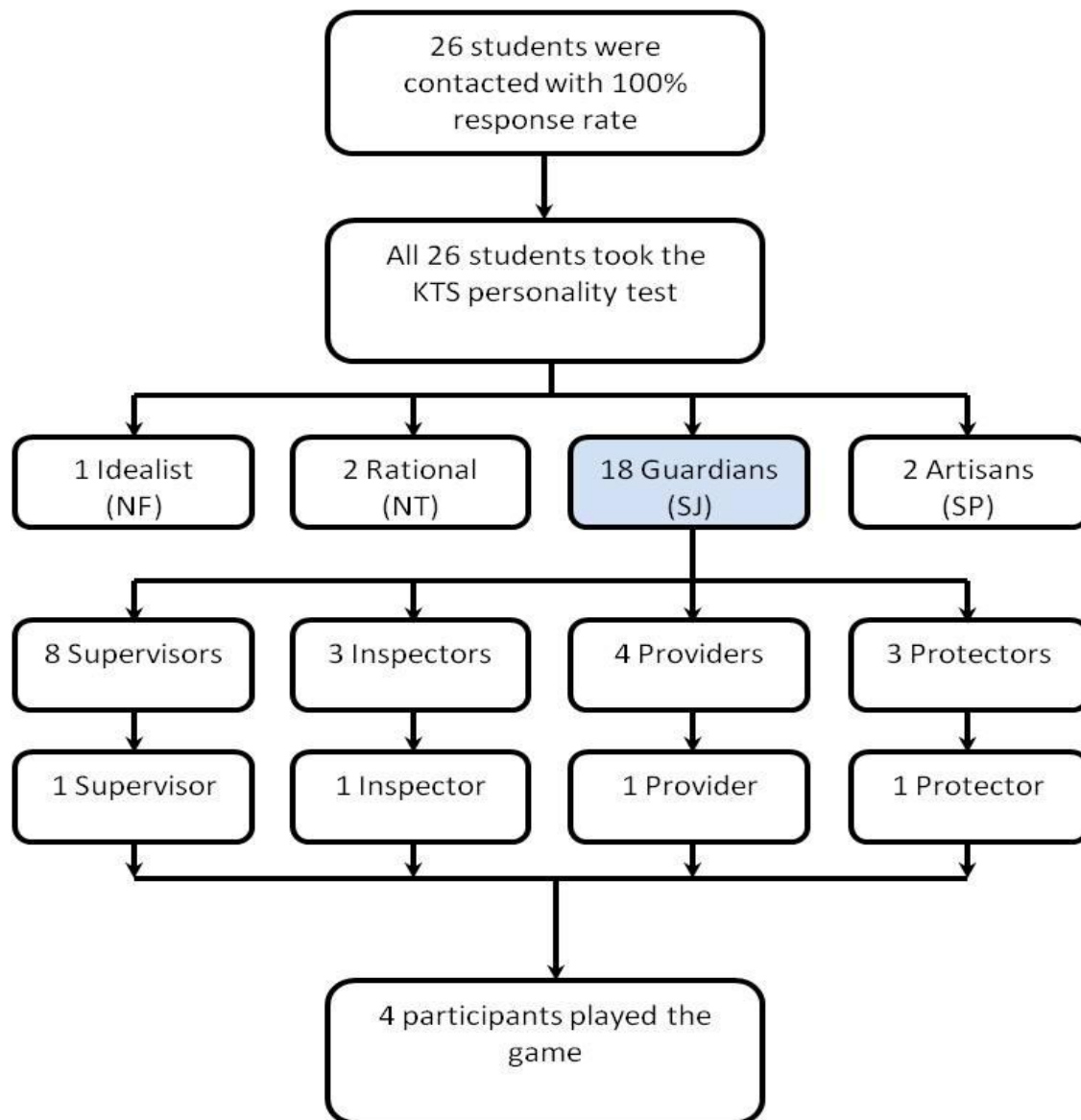
Figure 9 shows the flow of the participants in the study.

#### SELECTION OF ROLE VARIANTS

The selection of the role variants depends upon their strength in the KTS answer sheet. The strength depends upon the number of questions that are answered as the option designated in Table 5. It should be noted that out of the two options available namely, EI, SN, TF, JP, the one with the higher number gets selected. The combination of the selected four letters out of the eight mentioned gives the role variant of an individual. The higher difference in the combinations describes the strength of the participant. If the two numbers are almost equal then the strength of the participant becomes weak.

## RAB GAME PLAY

The game was played on June 10, 2010 at TAMU. The total duration of the game was three hours with nine games of 20 minutes each. The participants with their unique usernames and personalities are presented in Table 6.



**Figure 9.** Flow of Participants in the Study

Table 5

*Selection of Players*

a	b	a	b	a	b	a	b	
8	2	17	3	17	3	18	2	Strong Supervisor
<u>E</u>	I	<u>S</u>	N	<u>I</u>	F	<u>J</u>	P	
2	8	18	2	16	4	15	5	Strong Inspector
E	<u>I</u>	<u>S</u>	N	<u>I</u>	F	<u>J</u>	P	
9	1	14	6	6	14	15	5	Strong Provider
<u>E</u>	I	<u>S</u>	N	T	<u>E</u>	<u>J</u>	P	
1	9	14	6	7	13	16	4	Strong Protector
E	<u>I</u>	<u>S</u>	N	T	<u>E</u>	<u>J</u>	P	

Table 6

*Player and Personality Type*

Assigned Number	Username	Personality
1	Hammer Co.	Provider
2	Driver Co.	Protector
3	Pliers Co.	Supervisor
4	Concrete Co.	Inspector

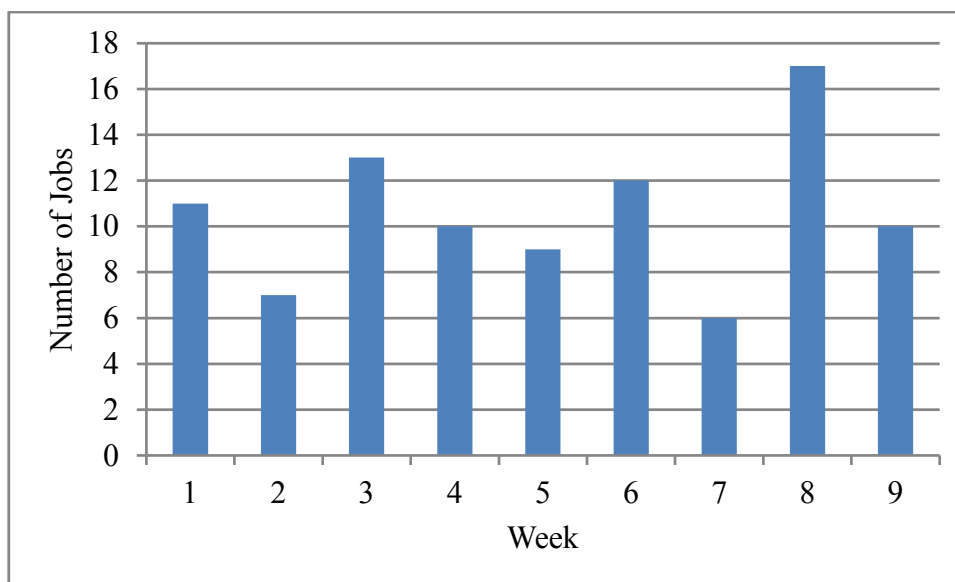
Table 7 represents the number of available jobs to each bidder during the course of the game.

Table 7

*Number of Job Per Week and Descriptive Statistics*

Week	Number of Jobs
1	11
2	7
3	13
4	10
5	9
6	12
7	6
8	17
9	10
Mean	10.56
Std. deviation	3.28
Total	95

The results of Table 7 are graphically represented in the histogram shown in Figure 10.

**Figure 10.** Number of Jobs Per Week

Chouhan (2009) postulated a typical trend of the bidding behavior of participants in the course of the game (refer to Table 8). This behavior more or less remains unchanged in the studies followed thereafter. Thus to relate to previous studies, the behavior of the current participants is analyzed to mark the difference between the personality type of the participants. As all the previous games were played with the four major personalities and not the 16 role variants, it is interesting to compare the bidding trend of all the participants being from the Guardian type personality.

Table 8

*Trend Periods and Data as Postulated by Chouhan (2009)*

Period Identifier	Description of the Trend Period
A	Learning
B	Discovering
C	Competitive
D	Profit Gain

To analyze the bidding trend of the current participants, the bids are divided into nine consecutive game plays. The profit gained by the winning bidder assists in identifying the trend. Table 9 provides the data of the profit and the winner in the first 15 minutes of the game play. It can be seen that there are two negative bids confirming that all the participants have not yet acclimatized to the game play situation. Thus they have made errors in the process of bidding. The participants are in their learning phase. The discovering trend of the participants is not coherent in this study. This may be due to their winning personality type.

Table 9

*First Bid Period*

Job No.	Revised No.	Cost (\$)	Profit (\$)	Bidder ID
1389	1	\$14,725.00	\$25.00	1
1390	2	\$14,914.00	\$186.00	1
1391	3	\$18,316.00	\$684.00	4
1392	4	\$11,701.00	\$248.00	4
1393	5	\$18,316.00	-\$453.00	4
1394	6	\$12,835.00	\$515.00	4
1395	7	\$13,213.00	\$487.00	4
1396	8	\$13,213.00	\$787.00	4
1397	9	\$13,213.00	-\$213.00	4
1398	10	\$14,725.00	\$274.00	4
1399	11	\$13,213.00	\$178.00	1

Tables 10, 11, 12 and 13 confirm to the literature that the participants of the Guardian type personality are the most competent bidders and thus the competitive behavior of these participants can be seen in the respective tables. The highest profit gain on this phase of the game has been \$1,213, \$264, \$3,299 and \$337 (week 2, 3, 4 and 5), confirming the competitive nature of each participant.

Table 10

*Second Bid Period*

Job No.	Revised No.	Cost (\$)	Profit (\$)	Bidder ID
1400	12	\$11,701.00	\$1.00	4
1401	13	\$18,316.00	\$1.00	2
1402	14	\$11,701.00	\$0.00	4
1403	15	\$13,213.00	\$0.00	4
1404	16	\$18,316.00	\$0.00	2
1405	17	\$13,213.00	\$0.00	4
1406	18	\$13,213.00	\$1,213.00	4

Table 11

*Third Bid Period*

Job No.	Revised No.	Cost (\$)	Profit (\$)	Bidder ID
1407	19	\$13,213.00	\$36.00	3
1408	20	\$11,701.00	\$99.00	3
1409	21	\$14,725.00	\$55.00	4
1410	22	\$13,213.00	-\$13.00	3
1411	23	\$11,701.00	\$97.00	3
1412	24	\$11,701.00	-\$1.00	4
1413	25	\$14,725.00	\$264.00	4
1414	26	\$14,725.00	\$255.00	4
1415	27	\$18,316.00	\$164.00	3
1416	28	\$14,914.00	\$76.00	4
1417	29	\$14,725.00	\$75.00	3
1418	30	\$14,914.00	\$86.00	3
1419	31	\$14,725.00	\$75.00	3
1420	32	\$14,725.00	\$254.99	4



Table 12

*Fourth Bid Period*

Job No.	Revised No.	Cost (\$)	Profit (\$)	Bidder ID
1421	33	\$18,316.00	\$684.00	3
1422	34	\$18,316.00	-\$16.00	2
1423	35	\$14,725.00	\$275.00	1
1424	36	\$14,725.00	\$275.00	4
1425	37	\$11,701.00	\$299.00	1
1426	38	\$18,316.00	\$184.00	4
1427	39	\$11,701.00	\$198.00	1
1428	40	\$14,914.00	\$536.00	4
1429	41	\$11,701.00	\$3,299.00	1
1430	42	\$12,835.00	\$65.00	4

Table 13

*Fifth Bid Period*

Job No.	Revised No.	Cost (\$)	Profit (\$)	Bidder ID
1431	43	\$13,213.00	-\$213.00	4
1432	44	\$13,213.00	\$120.00	3
1433	45	\$11,701.00	\$199.00	4
1434	46	\$12,835.00	\$165.00	4
1435	47	\$12,835.00	\$165.00	4
1436	48	\$14,914.00	\$86.00	4
1437	49	\$18,316.00	\$83.00	2
1438	50	\$13,213.00	\$337.00	1
1439	51	\$13,213.00	\$87.00	3

Tables 14, 15, 16 and 17 shows a sudden increase in the profit margin of all the participants and confirms to the bidding profit gain bidding trend as postulated by Chouhan (2009). Although this trend starts earlier than the previous studies again

conforming the fact that Guardians are the most appropriate personality for the RAB process. This table shows that this trend is continued till the end of the game with each bidder making maximum profit gains in the last four weeks of the game play.

Table 14

*Sixth Bid Period*

Job No.	Revised No.	Cost (\$)	Profit (\$)	Bidder ID
1440	52	\$18,316.00	\$41,684.00	4
1441	53	\$11,701.00	\$7,299.00	1
1442	54	\$18,316.00	\$41,684.00	1
1443	55	\$14,914.00	\$25,086.00	1
1444	56	\$13,213.00	\$31,787.00	4
1445	57	\$13,213.00	\$31,787.00	4
1446	58	\$12,835.00	\$27,165.00	4
1447	59	\$12,835.00	\$31,165.00	2
1448	60	\$18,316.00	\$41,684.00	2
1449	61	\$14,725.00	\$36,275.00	2
1450	62	\$18,316.00	\$43,684.00	3
1451	63	\$18,316.00	\$43,684.00	3
1452	64	\$13,213.00	\$26,786.00	4

Table 15

*Seventh Bid Period*

Job No.	Revised No.	Cost (\$)	Profit (\$)	Bidder ID
1453	65	\$14,914.00	\$34,084.00	2
1454	66	\$13,213.00	\$26,787.00	1
1455	67	\$18,316.00	\$30,684.00	1
1456	68	\$12,835.00	\$28,165.00	3
1457	69	\$14,725.00	\$4,275.00	1
1458	70	\$13,213.00	\$33,032.00	4

Table 16

*Eighth Bid Period*

Job No.	Revised No.	Cost (\$)	Profit (\$)	Bidder ID
1459	71	\$13,213.00	\$33,032.00	4
1460	72	\$13,213.00	\$33,032.00	4
1461	73	\$14,725.00	\$35,275.00	4
1462	74	\$18,316.00	\$41,684.00	1
1463	75	\$11,701.00	\$27,299.00	1
1464	76	\$18,316.00	\$42,684.00	1
1465	77	\$12,835.00	\$30,165.00	1
1466	78	\$12,835.00	\$27,165.00	3
1467	79	\$14,725.00	\$35,275.00	2
1468	80	\$14,725.00	\$35,275.00	2
1469	81	\$13,213.00	\$32,787.00	2
1470	82	\$13,213.00	\$32,787.00	2
1471	83	\$14,914.00	\$35,086.00	3
1472	84	\$14,914.00	\$35,086.00	3
1473	85	\$14,725.00	\$35,275.00	3
1474	86	\$13,213.00	\$31,787.00	3

Table 17

*Ninth Bid Period*

Job No.	Revised No.	Cost (\$)	Profit (\$)	Bidder ID
1477	87	\$12,835.00	\$31,165.00	2
1479	88	\$12,835.00	\$27,165.00	1
1480	89	\$14,914.00	\$36,586.00	1
1481	90	\$14,914.00	\$36,086.00	1
1482	91	\$11,701.00	\$28,299.00	3
1483	92	\$14,914.00	\$30,086.00	3
1484	93	\$11,701.00	\$28,299.00	3

Table 18 compares the results of the bid periods using the studentst test analysis to confirm the bidding trends as postulated by Chouhan (2009). The bidding period 1 is significantly different from the bidding period 2, thus confirming the learning phase of the participants. Bidding periods 2, 3, 4 and 5 are similar and the participants gain significantly less profit in these weeks confirming the competitive trend in the game play. The bidding period 6, 7, 8 and 9 are again similar, but significantly different from bidding period 5 as all the participants make a huge profit gain in these weeks and confirm to the profit gaining phase of the game play.

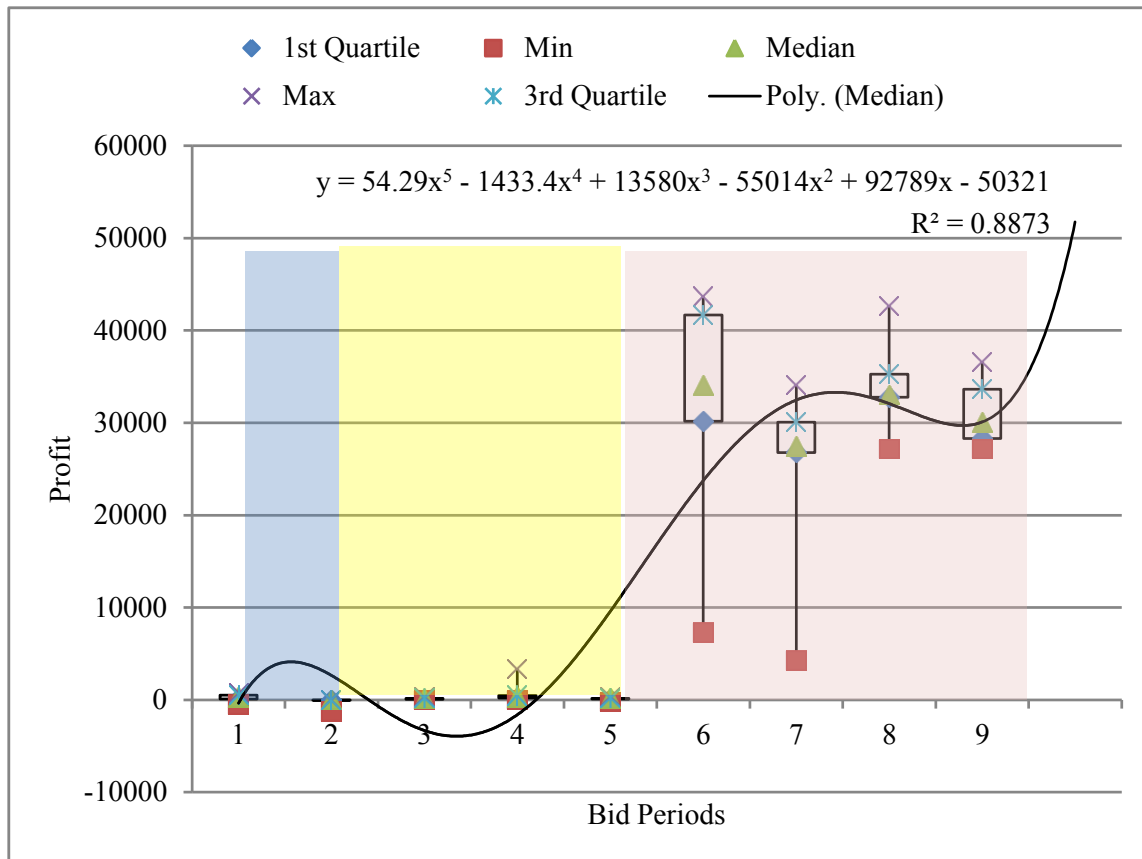
Table 18

*Students T Test Analysis*

<b>Bid Period</b>	<b>Compared to</b>	<b>Students t test</b>	<b>Difference</b>
1	2	2.14	Significant
2	3	1.35	Not Significant
3	4	1.81	Not Significant
4	5	1.41	Not Significant
5	6	9.45	Significant
6	7	1.60	Not Significant
6	8	0.12	Not Significant
6	9	0.59	Not Significant

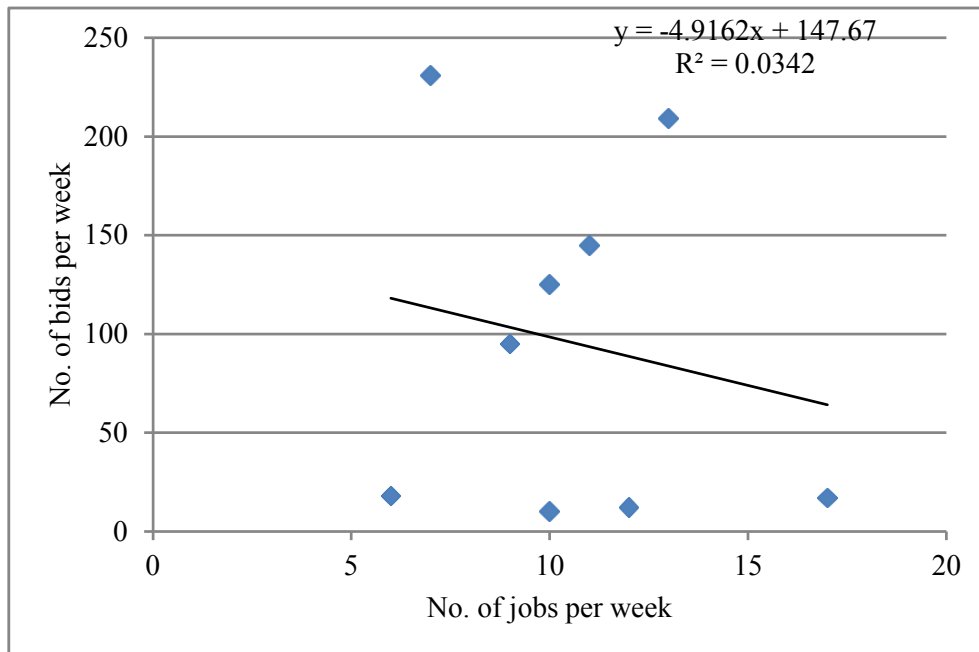
Figure 11 represents the nature of the bidding during the course of the game. Three different phases can be clearly marked as learning and discovering, competitive and profit gain. The boxplot shows the profit range of the participants. The trend line to the order of fifth polynomial is generated to explicitly show the characteristics of the data. The trend is further increase by one interval to predict the future of the profit gain for all the participants. The R-square value of 0.8873 shows a strong trend of this trend

being positive. Thus it can be said that all the participants would gain higher profits if the game was played further.



**Figure 11.** Boxplot for Profit

Figure 12 represents a trend for the number of jobs against the number of bids, although it does not follow a perfect pattern a steady increase in the number of bids is seen with the increase in the number of jobs.



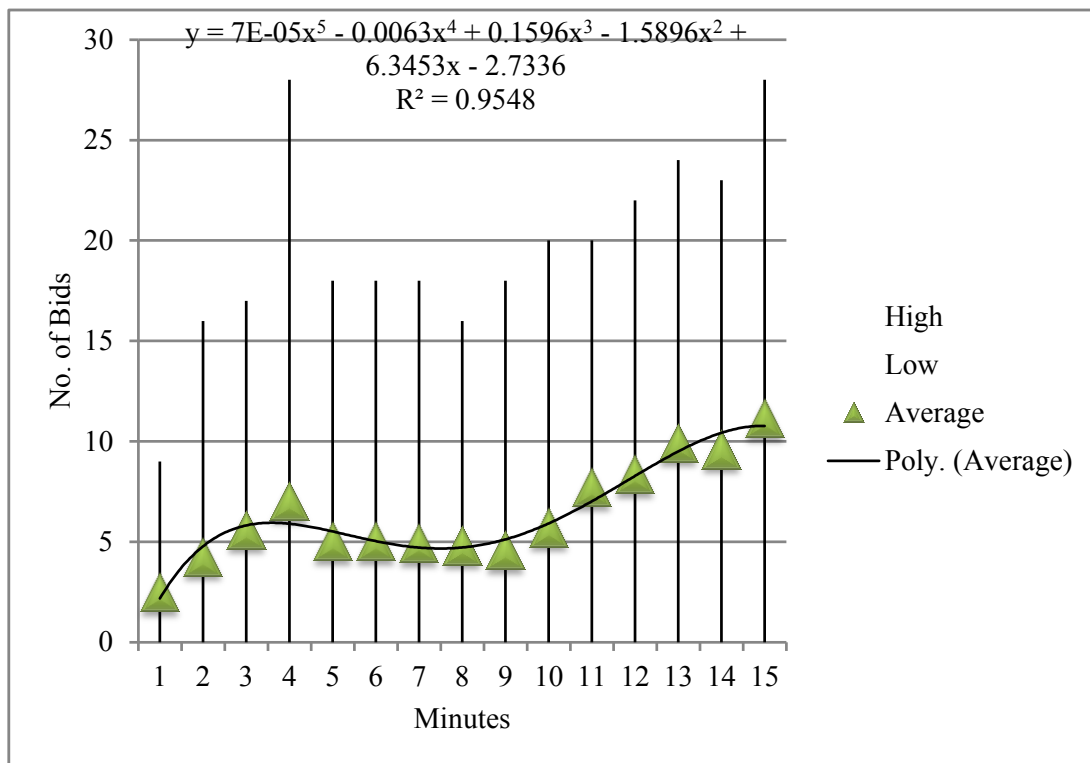
**Figure 12.** No. of Bids v/s No. of Jobs

Table 19 and Figure 13 illustrate the number of bids in each minute of the game play. A trend is clearly seen and there seems to be an increase in the number of bids in the last minute of the game. This shows that each competitor tries to outbid the other by placing consecutive bids.

Table 19

*High, Low and Average bids in each minute*

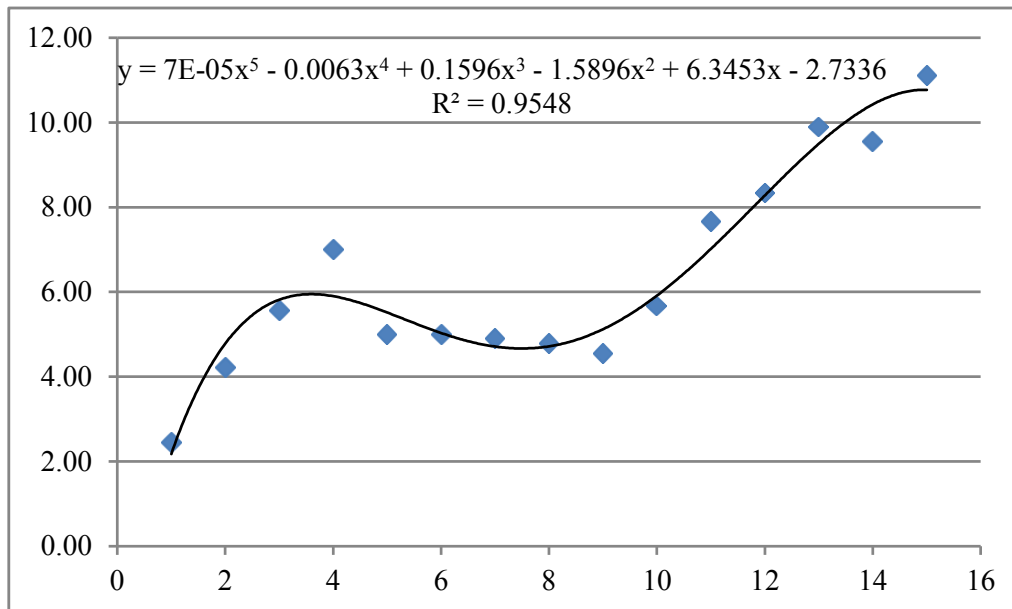
Minute	High	Low	Average
1	9	0	2.44
2	16	0	4.22
3	17	0	5.56
4	28	0	7.00
5	18	0	5.00
6	18	0	5.00
7	18	0	4.89
8	16	0	4.78
9	18	0	4.56
10	20	0	5.67
11	20	0	7.67
12	22	0	8.33
13	24	0	9.89
14	23	0	9.56
15	28	0	11.11



**Figure 13.** High, Low and average bid in Every Minute Boxplot

The trend line in Figure 14 also shows an increase. The R-square value of 0.9548 also helps in confirming this trend.

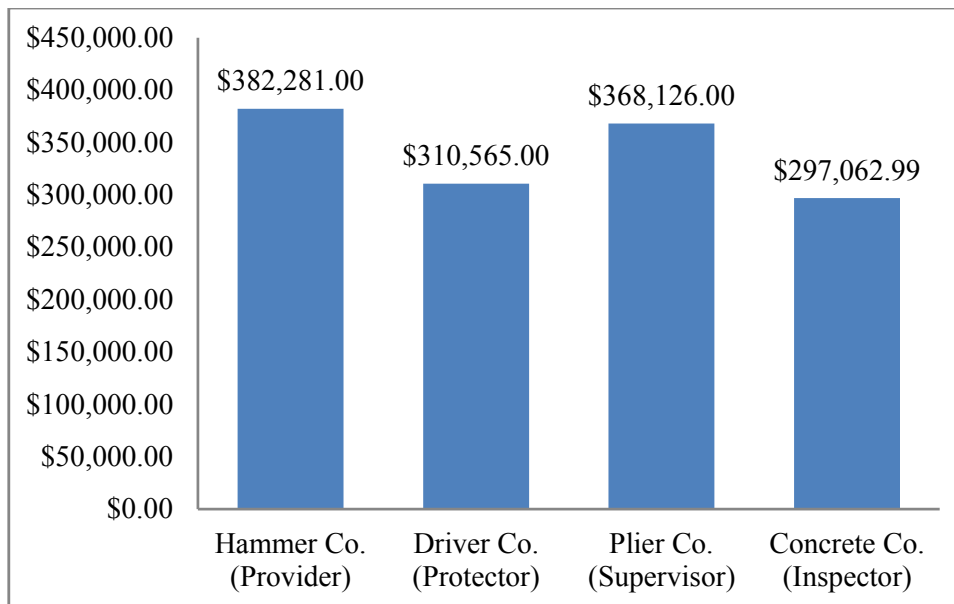




**Figure 14.** Trend of Average Bids per Minute

## ANALYSIS

Figure 15 summarizes the total profit gain by each participant and the clear winner in the role variant of Provider (Hammer Co.) is achieved. The KTS questionnaire of a previous study also brings out the fact that the Guardian winner was of the same role variant. This reinforces the result of this study.



**Figure 15.** Profit Data for Each Bidder

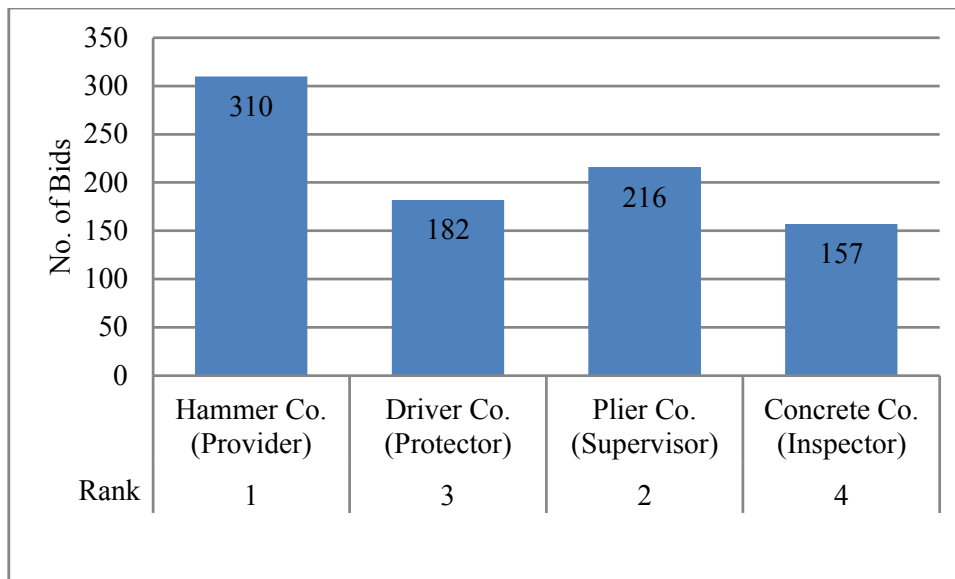
Table 20 summarizes the results obtained for the overall performance in the game.

Table 20

*Ranking of the Various Role Variants*

Rank	Personality
1	Provider
2	Supervisor
3	Protector
4	Inspector

Figure 16 shows that the number of bids placed by the winner (Provider) was significantly higher than the other participants. It thus represents the aggressive bidding nature of this role variant.



**Figure 16.** No. of Bids v/s Rank

Table 21 shows that Provider has won the second highest jobs, but still has made larger profits than the other participants. This suggests that this role variant has gained a higher profit in less number of jobs.

Table 21

*Bid Efficiency of Each Personality*

Rank	Personality	No. of Bids	Jobs Won	Bid Efficiency (%)
1	Provider	310	22	7.10
2	Supervisor	216	13	6.02
3	Protector	182	22	12.09
4	Inspector	157	38	24.20

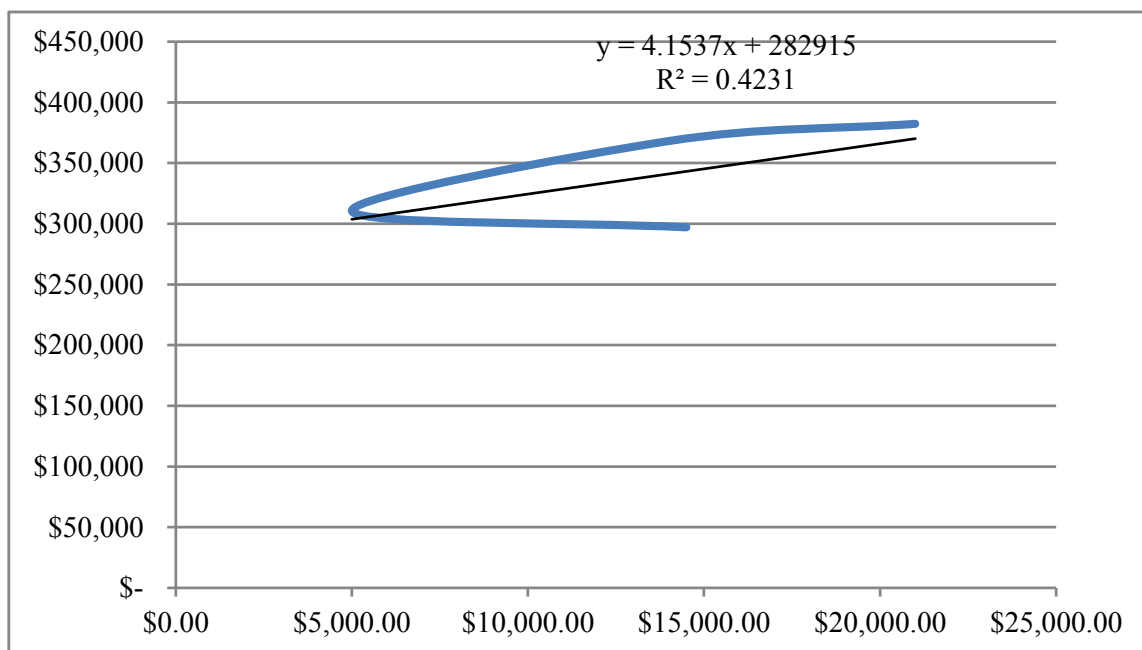
Table 22 and Figure 17 represent and confirm to previous studies that the participants who have taken more bank loans have achieved a higher profit gain by the

end of the game (Chouhan, 2009; Peterson, 2010; Saigaonkar, 2010). The positive R-square value of 0.4231 shows that this trend can be traced further.

Table 22

*Bank Loan and Profit Data*

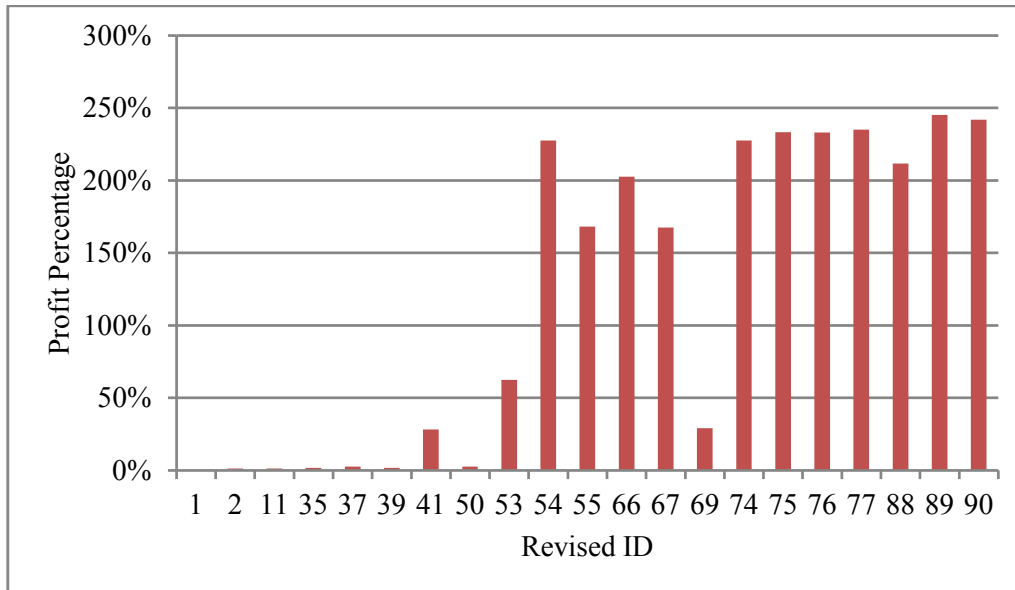
Rank	Personality	Loan	Total Profit
1	Provider	\$21,000.00	\$ 382,281.00
2	Supervisor	\$14,000.00	\$ 368,126.00
3	Protector	\$5,000.00	\$ 310,565.00
4	Inspector	\$14,500.00	\$ 297,062.99



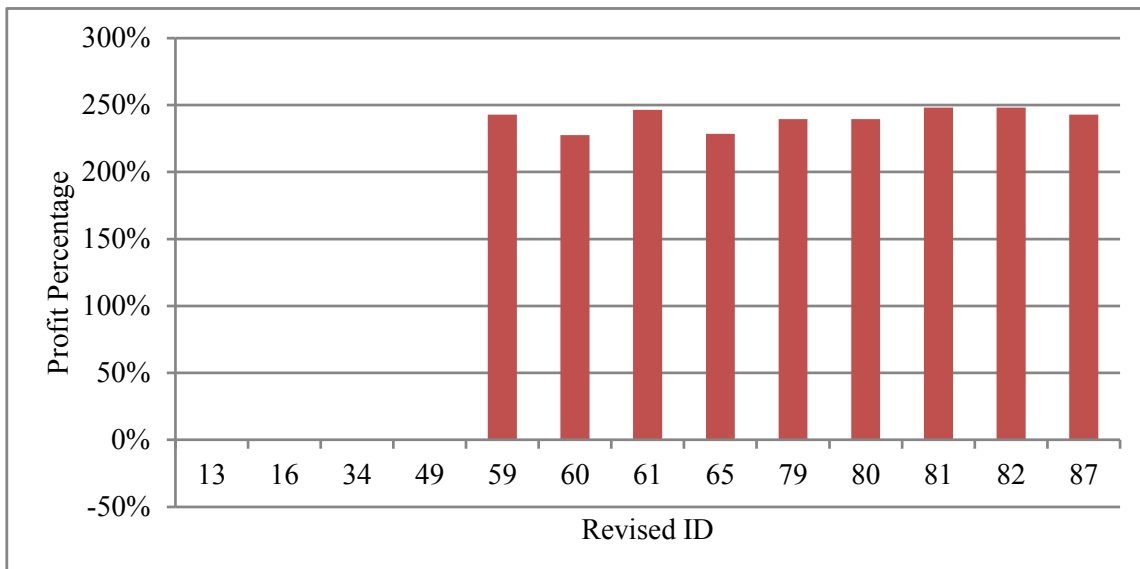
**Figure 17.** Bank Loan against Profit

Figures 18, 19, 20 and 21 illustrate the profit percentage of each of the role variants of Provider, Protector, Supervisor and Inspector respectively with respect to the revised Job ID's. The Job ID's were revised for the purpose of making the study easier to read. The unaltered ID's always increase with the consecutive game plays and in this

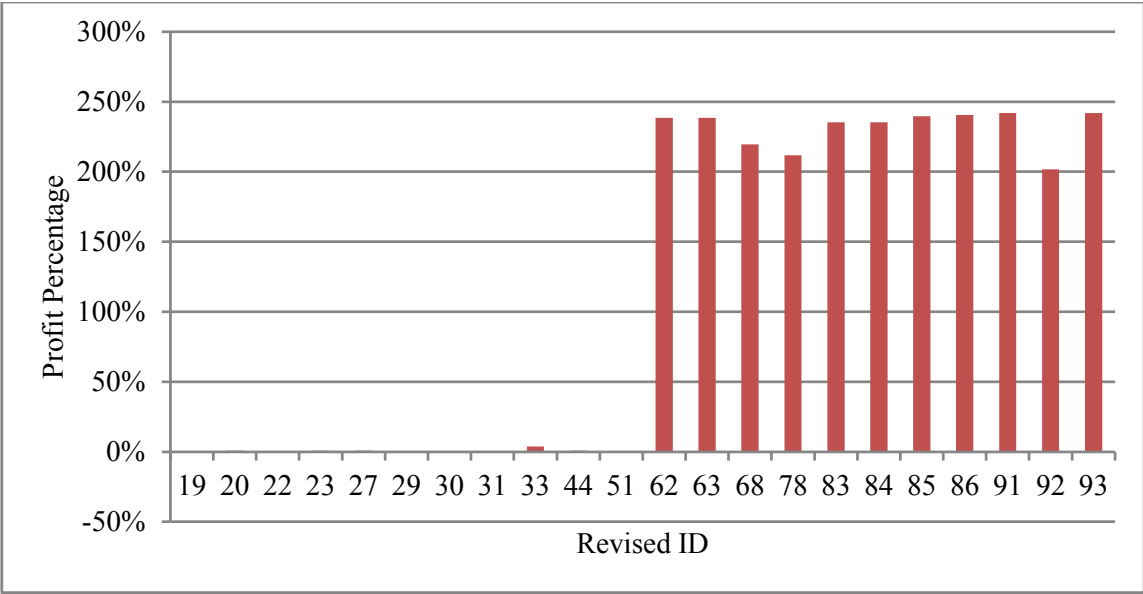
case the ID's began from 1389, thus representing that 1388 jobs have already been offered to participants of previous studies. Here it is observed that the Provider started making the profit gain earlier than the other role variants thus taking an early lead.



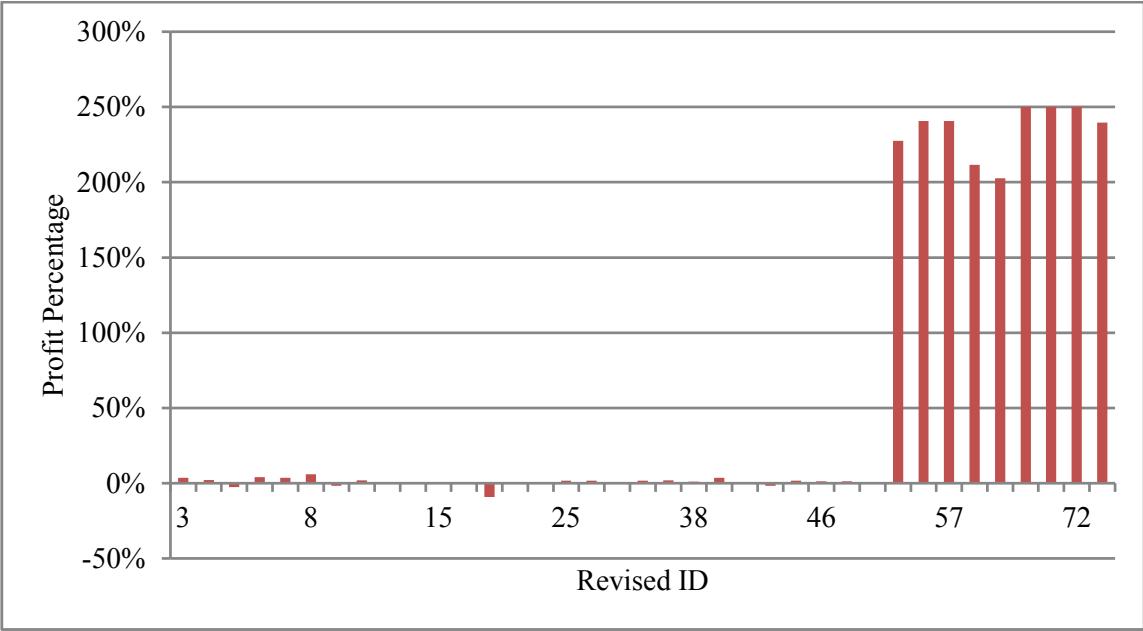
**Figure 18.** Profit Percentage against Revised ID for Provider



**Figure 19.** Profit Percentage against Revised ID for Protector



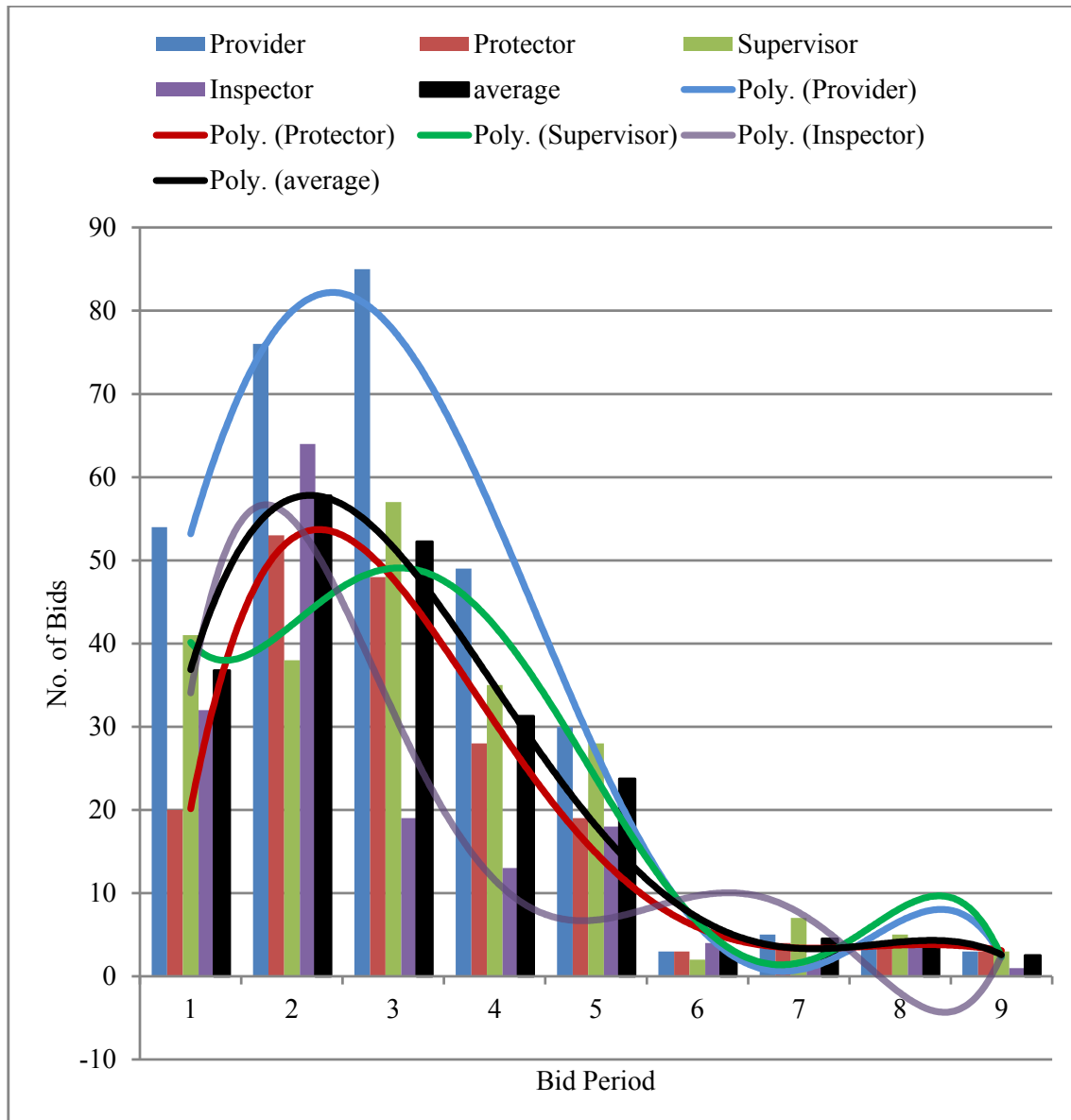
**Figure 20.** Profit Percentage against Revised ID for Supervisor



**Figure 21.** Profit Percentage against Revised ID for Inspector

Figure 22 illustrates the bidding trend for each of the role variants. As explained earlier the Provider is more aggressive and makes significantly higher number of bids

than the average and the rest of the participants. The Provider also makes these bids early in the game process and thus even if the condition of taking a bank loan is raised, the Provider takes as many jobs as possible to take the initial lead.



**Figure 22.** Bidding Trend

Table 23 confirms the above trend by separating the number of bids per minute for each participant. Here also it is observed that the Provider makes higher amounts of bid early in the game and outplays the other competitors. The average number of bids by the Provider is also seen to be higher than the other role variants.

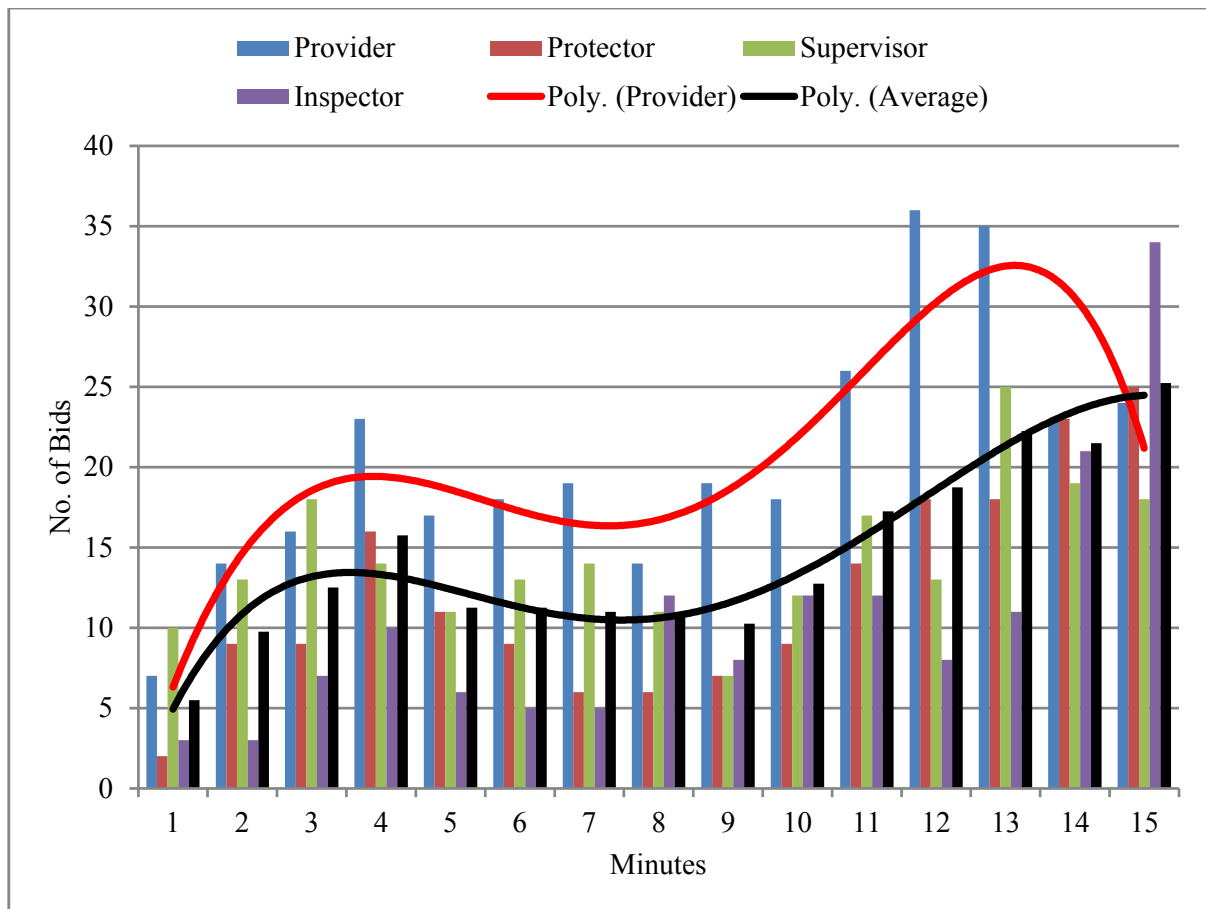
Table 23

*Number of Bids per Minute*

Minutes	Provider	Protector	Supervisor	Inspector	Average
1	7	2	10	3	5.5
2	14	9	13	3	9.75
3	16	9	18	7	12.5
4	23	16	14	10	15.75
5	17	11	11	6	11.25
6	18	9	13	5	11.25
7	19	6	14	5	11
8	14	6	11	12	10.75
9	19	7	7	8	10.25
10	18	9	12	12	12.75
11	26	14	17	12	17.25
12	36	18	13	8	18.75
13	35	18	25	11	22.25
14	23	23	19	21	21.5
15	24	25	18	34	25.25
Avg.	20.6	12.13	14.33	10.46	

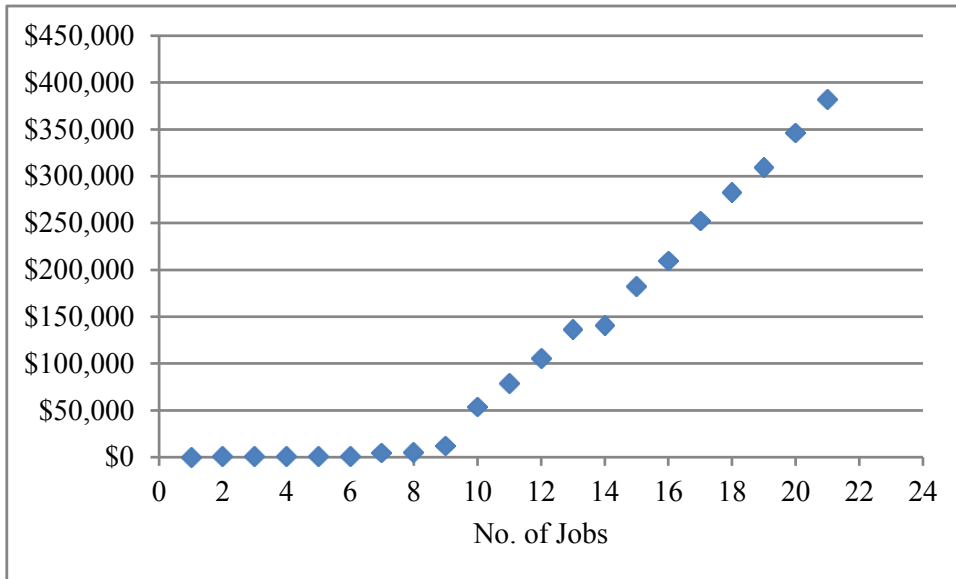
Figure 23 is the graphical representation of the Table 23 and it is observed that the numbers of bids in each minute of the game play are higher for the Provider than the average.



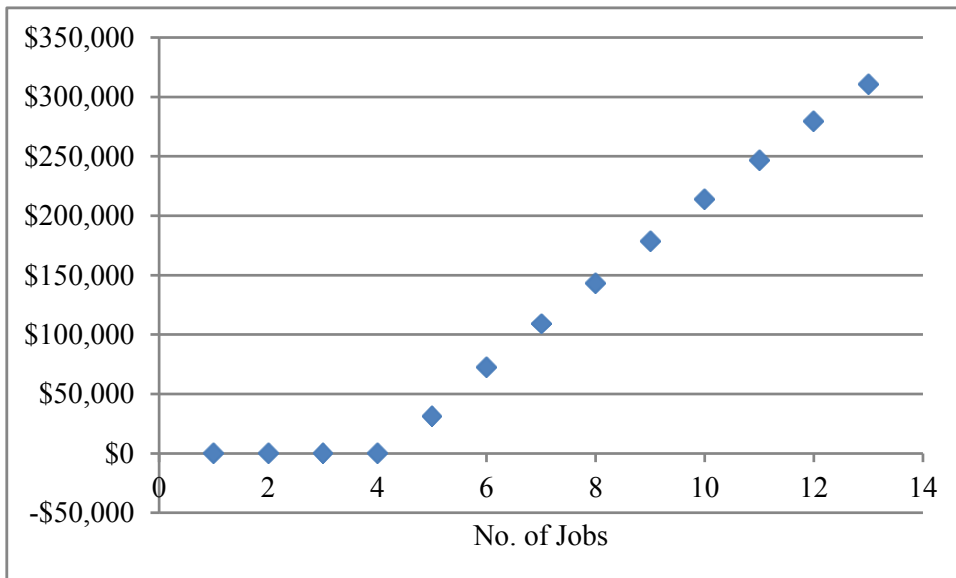


**Figure 23.** No. of bids per Minute- Comparison

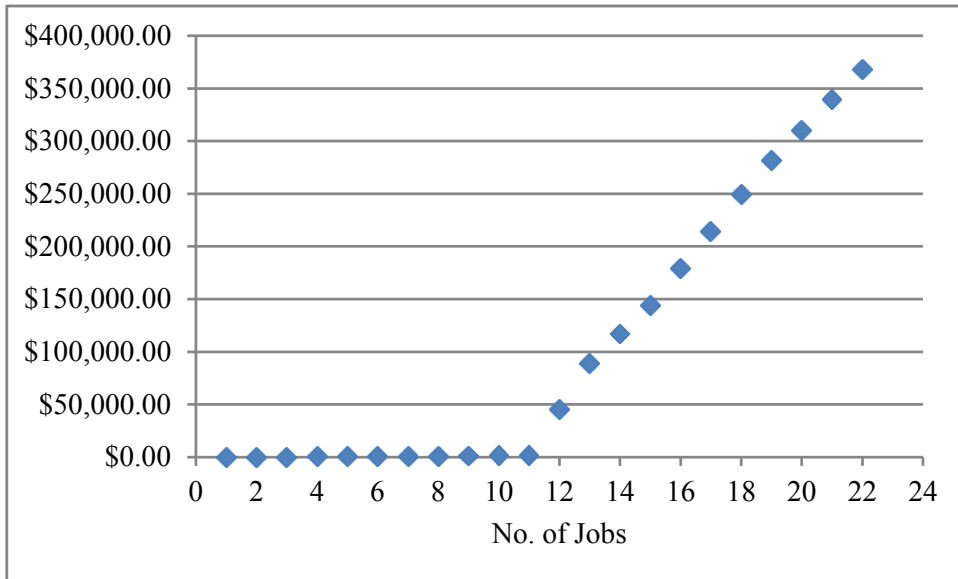
Figures 24, 25, 26 and 27 represent the amount of money gained by each participant cumulatively. It is observed that the role variant of Protector has won the least number of jobs and thus could not gain the maximum profit. The Supervisor has won the same amount of jobs as the Provider, but the Provider starts making higher profits earlier than the former and thus the Supervisor could not recover the losses from the early acquired jobs. The inspector, although wins the highest number of jobs, but makes higher profits late in the game process thus making recovery almost impossible.



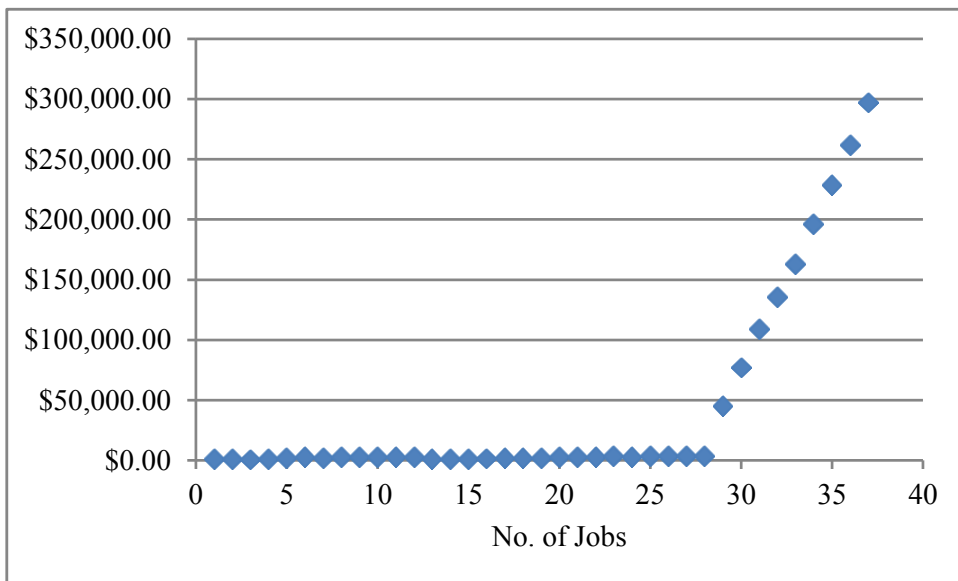
**Figure 24.** Amount of Money in Bank with the No. of Jobs for Provider



**Figure 25.** Amount of Money in Bank with the No. of Jobs for Protector



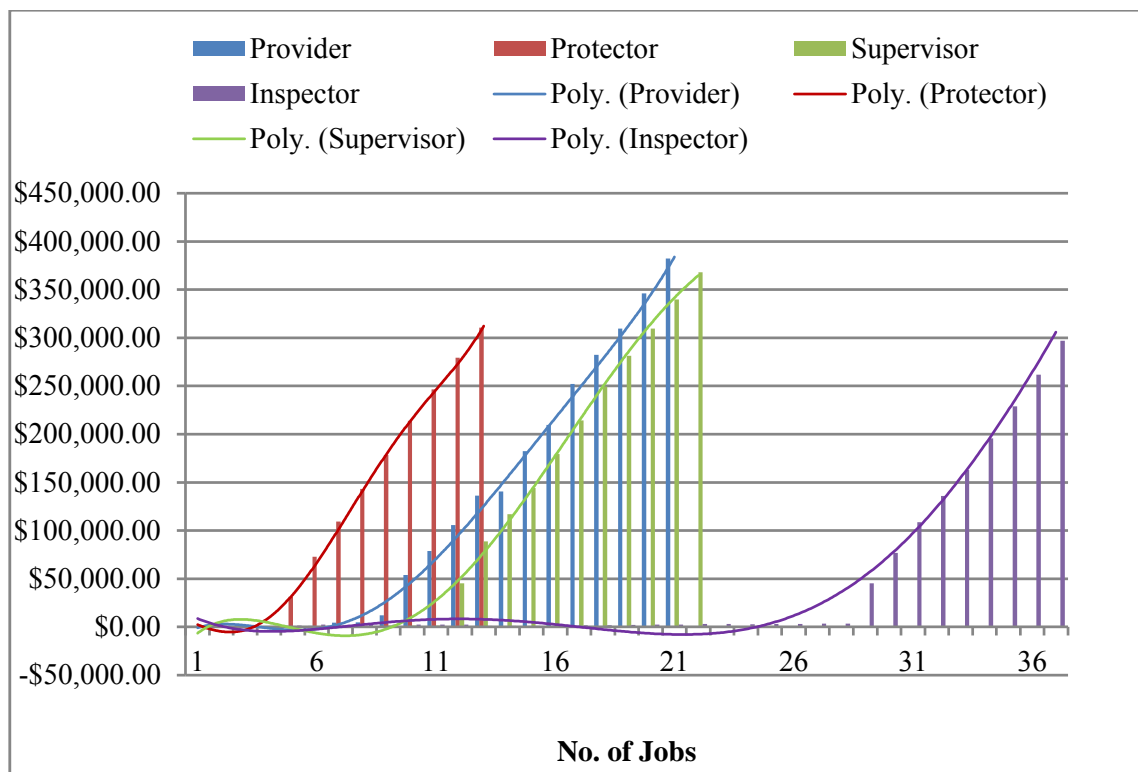
**Figure 26.** Amount of Money in Bank with the No. of Jobs for Supervisor



**Figure 27.** Amount of Money in Bank with the No. of Jobs for Inspector

Figure 28 provides a good comparison of the scenario of the financial condition of each of the role variants. As explained earlier the Supervisor and the Provider

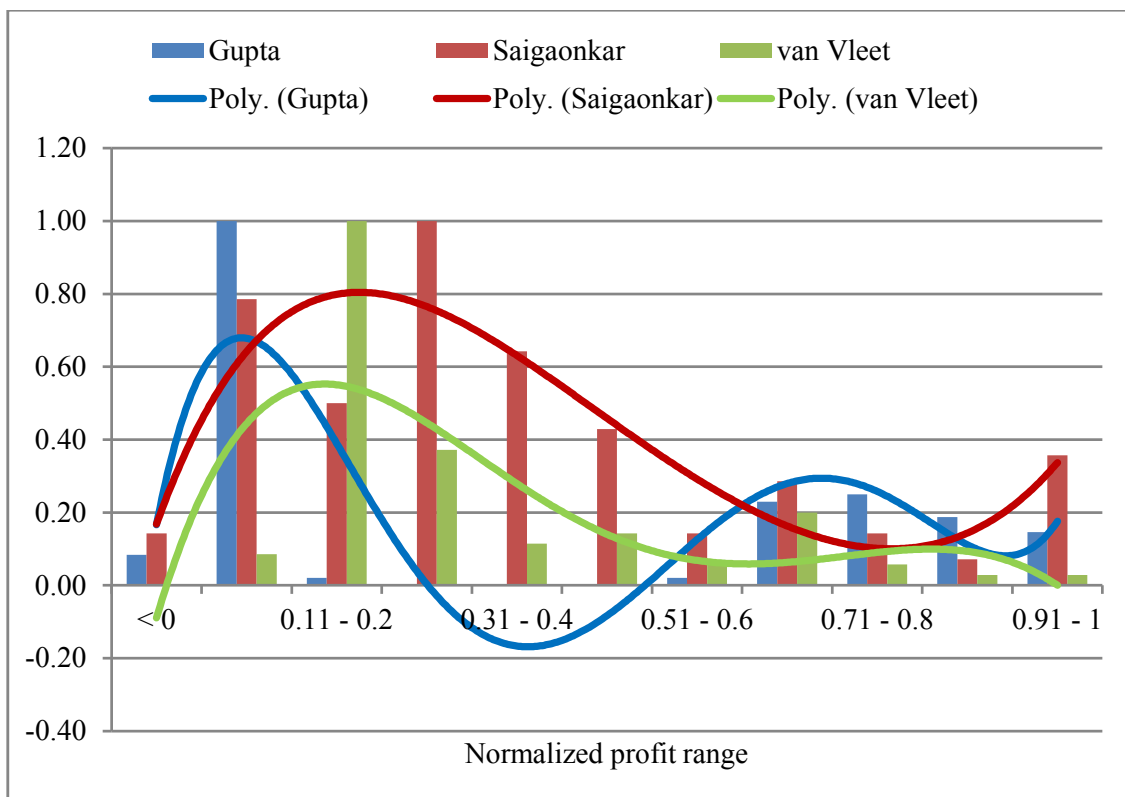
although win the same number of jobs the early profit gain achieved by the latter decides the outcome of the game.



**Figure 28.** Comparison of Money in Bank

Figure 29 and Table 24 compare this study and the behavior of participants to the previous studies. As all the previous studies studied the behavior of four major personalities (Guardian, Rational, Artisan and Idealist), it is interesting to observe the pattern of four of the role variants of the previously winning personality. The normalized profit is achieved by dividing all the profits in every job, by the maximum profit achieved. This procedure hence provides a maximum profit of one. The number of jobs being offered to participants was again observed to be different in previous studies (van Vleet, 2004; Saigaonkar, 2010), this is shown in Table 25. Thus these were again

normalized using the same procedure. This procedure helps in making the comparison unbiased. It is witnessed that the participants in the current study are more competitive driving the profits in the lower range (0 to 0.11) than the previous studies. Although a high number of profits in the range of 0.71 to 0.8 indicates the strong understanding of the game thus gaining a high profit gain. The trend of previous studies is seen to be more stabilized than the current study. This may be due to less competitiveness of the participants involved.



**Figure 29.** Adjusted No. of Entries in the each Normalized Profit Range

Table 24

*Adjusted No. of Entries in Each Normalized Profit Range*

Range	Gupta	Saigaonkar	van Vleet
< 0	0.08	0.14	0.00
0 - 0.1	1.00	0.79	0.09
0.11 - 0.2	0.02	0.50	1.00
0.21 - 0.3	0.00	1.00	0.37
0.31 - 0.4	0.00	0.64	0.11
0.41 - 0.5	0.00	0.43	0.14
0.51 - 0.6	0.02	0.14	0.06
0.61 - 0.7	0.23	0.29	0.20
0.71 - 0.8	0.25	0.14	0.06
0.81 - 0.9	0.19	0.07	0.03
0.91 - 1	0.15	0.36	0.03

Table 25

*Actual No. of Entries in the Normalized Profit Range*

Range	Gupta	Saigaonkar	van Vleet
< 0	4	2	0
0 - 0.1	48	11	3
0.11 - 0.2	1	7	35
0.21 - 0.3	0	14	13
0.31 - 0.4	0	9	4
0.41 - 0.5	0	6	5
0.51 - 0.6	1	2	2
0.61 - 0.7	11	4	7
0.71 - 0.8	12	2	2
0.81 - 0.9	9	1	1
0.91 - 1	7	5	1

## CHAPTER V

### CONCLUSIONS

The study carries forward the ongoing research on RAB in TAMU. The previous studies helped in identifying the appropriate personality that proves to be the most competent for the RAB scenario. In this research, it is observed that the participants have a shorter learning phase and start making a high profit gain significantly earlier than the participants of previous studies. This bolsters the fact that the Guardians are the most proficient bidders.

Among the four different role variants of Guardians, it is observed that the Provider type variant is the most aggressive and the most vigilant bidder. The findings show that the Provider takes the least amount of time to learn the RAB process and takes the initial lead. The facilities management industry can use this research and the modified KTS that this study provides to employ individuals when the most competent personality to have larger profit gains.

This research can be taken one step further by studying the characteristics and the gaming pattern of individuals with the same type of role variant (Provider). The KTS survey has a marking system that helps identify the strength of the role variant. Future study of competitive bidding among Providers with different strengths would help observe the difference, if any, within the same type of role variant in the Guardian type personality

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APPENDIX A  
REVISED QUESTIONNAIRE

INTRODUCTION

The four letter abbreviation for the Provider type role variant is ESFJ (Keirsey 1998). The questionnaire provided below identifies the specific questions which define the correct answers (italicized) for each letter in the above abbreviation, thus defining the Provider type.

TYPE E QUESTIONS

No.	E type questions	Answers (Italicized)	Comments
1	When the phone rings do you	a. <i>hurry to get to it first</i> b. Wait for someone else to pick up the phone	
2	Waiting in line, do you often	a. <i>chat with others</i> b. stick to business	These questions help identify whether an individual is extrovert or introvert towards the society. This would also help in realizing the individuals' view towards the world.
3	At a party, do you	a. <i>interact with many, even strangers</i> b. interact with a few friends	
4	Does interacting with strangers	a. <i>energize you</i> b. tax your reserves	
5	Do you tend to	a. <i>say right out what's on your mind</i> b. keep your ears open	
6	Do you think of yourself as	a. <i>an outgoing person</i> b. a private person	
7	Are you the kind of person who	a. <i>is rather talkative</i> b. doesn't miss much	
8	At work do you tend to	a. <i>be sociable with your colleagues</i> b. keep more to yourself	
9	Do you consider yourself	a. <i>a good conversationalist</i> b. a good listener	
10	Are you inclined to be	a. <i>easy to approach</i>	

---

*b. somewhat reserved*

---

### TYPE S QUESTIONS

No.	S type questions	Answers (Italicized)	Comments
1	Are you more	<i>a. observant than introspective</i> <i>b. introspective than observant</i>	
2	Is it worse to	<i>a. have your head in the clouds</i> <i>b. be in a rut</i>	
3	Are you more	<i>a. sensible than ideational</i> <i>b. ideational than sensible</i>	
4	Are you more interested in	<i>a. what is actual</i> <i>b. what is possible</i>	This set of questions help observe the nature of an individual in terms of practicality towards work. The questions determine and differentiate between individuals with fundamental overtones and individuals with fanciful overtones.
5	Do you tend to be more	<i>a. factual than speculative</i> <i>b. speculative than factual</i>	
6	Do you like writers who	<i>a. say what they mean</i> <i>b. use metaphors and symbolism</i>	
7	Facts	<i>a. speak for themselves</i> <i>b. illustrate principles</i>	
8	Do you find visionaries and theorists	<i>a. somewhat annoying</i> <i>b. rather fascinating</i>	
9	Common sense is	<i>a. usually reliable</i> <i>b. frequently questionable</i>	
10	Children often do not	<i>a. make themselves useful enough</i> <i>b. exercise their fantasy enough</i>	
11	Are you more frequently	<i>a. a practical sort of person</i> <i>b. a fanciful sort of person</i>	
12	Do you speak more in	<i>a. particulars than generalities</i> <i>b. generalities than particular</i>	
13	Are you inclined to take what is said	<i>a. more literally</i>	

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14	Do you more often see	b. more figuratively a. <i>what's right in front of you</i>
15	Are you more likely to trust	b. what can only be imagined a. <i>your experiences</i>
16	Are you more inclined to feel	b. your conceptions a. <i>down to earth</i>
17	Do you prize in yourself	b. somewhat removed a. <i>a strong hold on reality</i>
18	Are you drawn more to	b. a vivid imagination a. <i>fundamentals</i>
19	In stories do you prefer	b. overtones a. <i>action and adventure</i>
20	Is it easier for you to	b. fantasy and heroism a. <i>put others to good use</i>
		b. identify with others

---

#### TYPE F QUESTIONS

No.	F type questions	Answers (Italicized)	Comments
1	With people are you usually more	a. firm than gentle b. <i>gentle than firm</i>	This set of questions discusses the relationships of an individual with other people in the community. These questions thus discuss the camaraderie of one in a team.
2	Are you more comfortable in making	a. critical judgments b. <i>value judgments</i>	
3	In making up your mind are you more likely	a. to go by data b. <i>to go by desires</i>	
4	In sizing up others do you tend to be	a. objective and impersonal b. <i>friendly and personal</i>	
5	Which appeals to you more:	a. consistency of thought b. <i>harmonious relationships</i>	
6	If you must disappoint someone are you	a. usually frank and straightforward b. <i>warm and considerate</i>	

---

- 7 In a heated discussion, do you
- stick to your guns
  - look for common ground*
- 8 Is it better to be
- Just
  - merciful*
- 9 When in charge of others do you tend to be
- firm and unbending
  - forgiving and lenient*
- 10 Are you more often
- a cool-headed person
  - a warm-hearted person*
- 11 Which is more of a compliment:
- “There’s a logical person”
  - “There’s a sentimental person”*
- 12 Which rules you more
- your thoughts
  - your feelings*
- 13 Is it worse to be
- softy
  - hard-nosed*
- 14 In trying circumstances are you sometimes
- too unsympathetic
  - too sympathetic*
- 15 Do you think of yourself as a
- tough-minded person
  - tender-hearted person*
- 16 Do you value in yourself more that you are
- reasonable
  - devoted*
- 17 Which seems the greater fault
- to be too compassionate
  - to be too dispassionate*
- 18 Are you swayed more by
- convincing evidence
  - a touching appeal*
- 19 Which do you wish more for yourself:
- strength of will
  - strength of emotion*
- 20 Do you see yourself as basically
- thick-skinned
  - thin-skinned*
-

## TYPE J QUESTIONS

No.	J type questions	Answers (Italicized)	Comments
1	Is clutter in the workplace something you	a. <i>take time to straighten up</i> b. tolerate pretty well	
2	Is it your way to	a. <i>make up your mind quickly</i> b. pick an choose at some length	
3	Do you prefer contracts to be	a. <i>signed, sealed, and delivered</i> b. settled on a handshake	
4	Are you more satisfied having	a. <i>a finished product</i> b. work in progress	
5	On the job do you want your activities	a. <i>scheduled</i> b. <i>unscheduled</i>	These questions discuss one's working culture and working ethics. The questions describe an individual's procedure of adapting to a new job.
6	Do you more often prefer	a. <i>final, unalterable statements</i> b. tentative, preliminary statements	
7	At work, is it more natural for you to	a. <i>point out mistakes</i> b. try to please others	
8	Are you more comfortable	a. <i>after a decision</i> b. before a decision	
9	Are you prone to	a. <i>nailing things down</i> b. exploring the possibilities	
10	In most situations are you more	a. <i>deliberate than spontaneous</i> b. spontaneous than deliberate	
11	When finishing a job, do you like to	a. <i>tie up all the loose ends</i> b. move on to something else	
12	Do you prefer to work	a. <i>to deadlines</i> b. just whenever	
13	Do you tend to choose	a. <i>rather carefully</i> b. somewhat impulsively	
14	Are you inclined to be more	a. <i>hurried than leisurely</i>	

- 15 Do you usually want things
- 16 Would you say you are more
- 17 Do you feel better about
- 18 Is it preferable mostly to
- 19 Do you tend to notice
- 20 Are you more
- b. leisurely than hurried
- a. *settled and decided*
- b. just penciled in
- a. *serious and determined*
- b. easy going
- a. *coming to closure*
- b. keeping your options open
- a. *make sure things are arranged*
- b. just let things happen naturally
- a. *disorderliness*
- b. opportunities for change
- a. *routinized than whimsical*
- b. whimsical than routinized
-



APPENDIX B  
IRB APPROVAL

**TEXAS A&M UNIVERSITY  
DIVISION OF RESEARCH AND GRADUATE STUDIES - OFFICE OF RESEARCH COMPLIANCE**

1186 TAMU, General Services Complex  
College Station, TX 77843-1186  
750 Agronomy Road, #3500

979.458.1467  
FAX 979.862.3176  
<http://researchcompliance.tamu.edu>

Human Subjects Protection Program

Institutional Review Board

**DATE:** 08-Jun-2010

**MEMORANDUM**

**TO:** GUPTA, APURVA K  
77843-3578

**FROM:** Office of Research Compliance  
Institutional Review Board

**SUBJECT:** Initial Review

**Protocol Number:** 2010-0429

**Title:** Studying Reverse Auction Bidding Game

**Review Category:** Expedited

**Approval Period:** 08-Jun-2010 **To** 07-Jun-2011

**Approval determination was based on the following Code of Federal Regulations:**

45 CFR 46.110(b)(1) - Some or all of the research appearing on the list and found by the reviewer(s) to involve no more than minimal risk.

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(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation or quality assurance methodologies.

(Note: Some research in this category may be exempt from the HHS regulations for

the protection of human subjects. 45 CFR 46.101(b)(2) and (b) (3). This listing refers only to research that is not exempt.)

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**Provisions:**

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This research project has been approved for one (1) year. As principal investigator, you assume the following responsibilities

1. **Continuing Review:** The protocol must be renewed each year in order to continue with the research project. A Continuing Review along with required documents must be submitted 30 days before the end of the approval period. Failure to do so may result in processing delays and/or non-renewal.
2. **Completion Report:** Upon completion of the research project (including data analysis and final written papers), a Completion Report must be submitted to the IRB Office.
3. **Adverse Events:** Adverse events must be reported to the IRB Office immediately.
4. **Amendments:** Changes to the protocol must be requested by submitting an Amendment to the IRB Office for review. The Amendment must be approved by the IRB before being implemented.
5. **Informed Consent:** Information must be presented to enable persons to voluntarily decide whether or not to participate in the research project.

This electronic document provides notification of the review results by the Institutional Review Board.

## VITA

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