CASH-FLOW SIMULATION GAME FOR TEACHING PROJECT CASH-FLOW FORECASTING

Euysup Shim, Illinois State University; Byung-Cheol Kim, Ohio University; Seongchan Kim, Western Illinois University

Abstract

Having a sufficient amount of cash in a construction project is critical to construction companies, and forecasting cash-flow in a construction project is, accordingly, very important. However, due to multiple factors and their impacts on cash-flow, it is not easy to teach impacts of multiple factors on cash-flow and how to forecast cash-flow in construction projects. This paper presents an educational simulation game, the Cash-flow Simulation Game, to help students in construction management programs learn how to forecast cash-flow as a supplementary method. The game simulates the physical transfer of cash among project participants and helps students visualize transactions of cash without complex calculations. The game is evaluated with regard to its applicability to teaching, based on students' perception by a questionnaire survey. The results of the questionnaire survey are discussed along with some benefits identified from the survey.

Introduction

The construction industry is notorious for its high bankruptcy rate of 20.37%, due to insufficient cash [1], and lack of liquidity is the first reason for construction companies' failure [2]. Therefore, it is very important that contractors estimate how much cash is required for construction projects in advance and to make sure this amount of cash is available during the construction phase.

Accordingly, students in construction management (CM) programs are required to learn features of cash-flow in construction projects and how to predict cash-flow for accreditation by the American Council for Construction Education [3]. Both cash inflow to a general contractor and cash outflow from a general contractor in a construction project are affected by many factors such as project owner's retainage, payment condition and progress payments. Also, cash-flow for construction projects is typically forecasted over several months. Therefore, impacts of these multiple factors on cash -flow over several months make it difficult for students in CM programs to concretize and visualize transfer of cash and predict cash-flow [4].

Game and simulation are instructional methods which encourage students' active participation [5] and have been used in construction education for teaching practical and technical skills [6]. However, no game or simulation has been developed and used for teaching cash-flow for construction projects and how to forecast cash-flow. Therefore, an educational game which simulates cash-flow to general contractors in construction projects and helps CM students visualize transfer of cash (hereafter referred to as the Cash-flow Simulation Game) was developed and played in a construction-finance-related course at one author's institution. The game is evaluated with regard to its applicability to teaching by a questionnaire survey. The purposes of this paper are to present the Cash-flow Simulation Game and to share the benefits and shortcomings of the game identified from the questionnaire survey.

Forecasting Cash-flow in Construction Education

Cash is the most important resource to contractors, who execute construction projects, and the lack of liquidity to support contractors' daily activities is one of the key reasons for contractor failure [7]. As the first requirement for securing sufficient amounts of liquidity available for construction projects, contractors need to predict cash-flow in a construction project. Accurate cash-flow forecasting provides the amount of cash needed to perform a contract. Furthermore, contractors can determine how much cash should be borrowed from financial institutions (overdraft) to cover the contract, if needed, and the amount of interest required to support the borrowed cash.

Due to the importance of cash-flow forecasting in construction projects, students in CM programs learn the features of cash-flow and how to forecast it. Also, CM programs are required to cover the subject of Forecasting Costs and Cash Flow Requirements [3] for accreditation by the American Council for Construction Education (ACCE).

Cash-flow to a general contractor in a construction project is determined and affected by several factors. First, cash-flow in a construction project is based on contract conditions. Cash-flow to a general contractor is composed of two flows: cash-in and cash-out. Cash inflows are affected by

billing procedure, payment timing, project owner's retention and others which are specified in contract conditions. On the other hand, cash outflows are determined by several factors: contract conditions with subcontractors (with regard to trade financing [8] and retention), legal requirements for labor-cost payments, and payment procedures for material costs. This amount of cash to be borrowed or invested (overdraft) can be determined when all of these factors are considered and calculated.

In addition to the factors described above, teaching the features of cash-flow and forecasting cash-flow involves other topics such as Cash Trap—the difference between cash inflow and cash outflow caused by the owner's retention and delay in the owner's payment [9]—and impact of front-end-loaded Schedule of Values (SoV). Figure 1 shows the factors related to forecasting cash-flow.

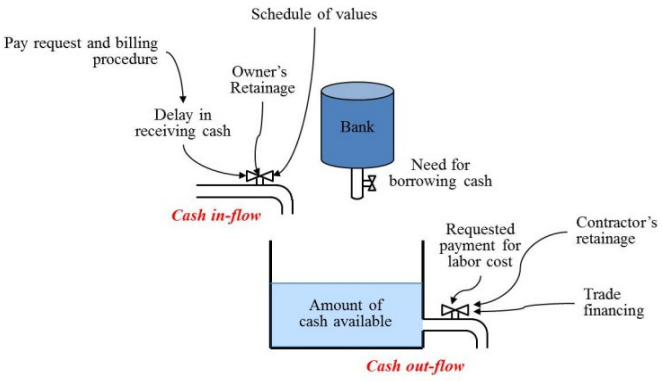

Figure 1. Influence Diagram for Cash-flow

Due to the combined impacts of several factors on cash-flow, learning cash-flow forecasting requires an understanding of the factors mentioned above and their impacts on cash-flows at first. Then, students can forecast the cash-flow of a construction project.

Teaching cash-flow forecasting may be performed in multiple approaches. The first approach is to teach rough cash-flow in construction projects based on monthly estimated cost. This approach can provide a general idea of cash-flow in construction projects; however, determination of the amount of money to be borrowed, if needed, cannot be explained under this approach. The second approach is to cover causes and features of cash-flow in construction projects. Under this approach, features and effects of the above factors on cash-flow are explained with a simple example, though how to forecast cash-flow is not covered [10], [11]. The last approach is to describe the causes and features of cash-flow and to explain how to forecast construction project cash-flows with a detailed example [2], [8].

While computer scheduling software can estimate cash-flows for a construction project, no software provides the complete set of capabilities needed for forecasting cash-flow at a project level: cost-loading activities, simultaneous loading of costs and contract values, and allowing the specifications of credit terms for payments [2]. Therefore, in the last approach described above, students can practice forecasting cash-flow in electronic spreadsheets such as Microsoft Excel at a relatively basic level. For example, the students at one author's institution are required to practice forecasting cash-flow on an Excel spreadsheet. In an example worksheet, the students are required to determine several values each month. However, it was observed that many students had difficulty calculating numbers on the spreadsheet. One of the difficulties observed was linking the multiple factors discussed earlier in the course and understanding the combined effect on cash-flow. For example, the cash -flow amount to be determined is not simply the difference between amount of cash-in (receipt amount) and amount of cash-out (payment amount). The students need to consider when they can receive cash from the project's owner and when they have to make payments to laborers, suppliers and subcontractors. However, as mentioned before, they are exposed to each of the factors separately and are expected to be able to link all of the factors and understand their combined impacts. Teaching forecasting of cash-flow requires that students understand the linkage and combined impacts of multiple factors on cash-flow, at least in an intuitive way.

Therefore, based on the authors' observations, it seems that students would need another activity, which can remind them of the previously covered topics/factors and help them link those topics altogether. While they can use Excel functions and fill handle to save time [8], the Excel functions or fill handle cannot be a substitute for understanding the combined impacts on cash-flow. Without understanding the linkage and combined impacts, working on an Excel spreadsheet with Excel functions and fill handle may make students more confused.

Game and Simulation for Enhanced Teaching

Gaming and simulation (or game-based learning) are instructional approaches in which student learning can be enhanced by active participation [5]; Weber [12] argues that the effectiveness of practice by doing is much higher than that of lecturing. In addition, the benefits of using game-based learning were identified by several researchers and educators [13] such as encouraging active learning, collaboration and interactivity.

Due to these benefits, game and simulation have been adopted in construction education. Also, it has been reported that hands-on learning is preferred by construction management students [14], [15]. Games or computer simulations were developed and used for teaching construction management courses. Some examples of the games (or simulations) developed and their focused areas are: Super-Bid for bidding skills [16]; the Equipment Replacement (*ER*) game for construction equipment replacement [17]; *CONSTRUCTO* for general management skills [18]; Negotiation game for tradeoff and negotiation skills [19]; the Parade of Trade game for impact of variability on productivity [20]; the *LEGO* Bridge game for estimating and planning [21]; the *LEAPCON* game for batch size determination [22]; and, the Poker game for risk management [23]. These games or simulations simulate real-world processes of construction projects, which help students with management-related decision making. Also, the games or simulations help students understand complex interactions among multiple construction processes.

While games or simulations have been developed for multiple areas in construction management education, no game or simulation for cash-flow or cash-flow projection in construction projects has been developed. The authors believe that forecasting cash-flow is the case in which benefits of simulation gaming for learning can be maximized because of the complex interaction and combined impacts of multiple factors. With a simulation game, students would be able to understand the linkage and impacts of multiple factors on cash-flow at an intuitive level and also practice cash-flow forecasting in a realistic setting.

The Cash-flow Simulation Game

Based on the needs for teaching and benefits of game/ simulation-based learning as discussed earlier, a hands-on game was developed to help CM students forecast cash-flow in construction projects as a supplementary method. The objectives of the development of the game are: 1) to help students understand interaction and the combined impacts of multiple factors related to cash-flow; 2) to remind students of industry procedures related to cash-flow; and, 3) to help students understand the impacts of different management policies on cash-flow. Under these objectives, the model was developed with the consideration of the success factors for the development of simulation [24]. Specifically, the authors focused on: 1) consideration of the importance of human factors; 2) focus on trade-offs associated with managerial decisions and construction policies; and, 3) easy -to-use stand-alone tools.

Assumptions for the Game

One of the key factors in cash-flow in construction projects is the contract conditions regarding payment timing (billing and payment procedure) and its amount, and retention between a project's owner and a general contractor, and also between a general contractor and subcontractors (or suppliers). While particular conditions in real construction contracts may vary depending on the location, feature and type of job, the relationship between the participants and simple assumptions for the Cash-flow Simulation Game were made based on one of the textbooks [8] as follows:

- On the last day of each month, the general contractor bills the project owner for work completed during the month.
- The project owner pays the monthly bills one month after receiving bills.
- The project owner holds 10% retention.
- Final payment to the general contractor is expected to be made one month after completion of the project and to include all of the retained money.
- The general contractor withholds 10% of payments to subcontractors.
- The general contractor pays for labor costs weekly.
- The general contractor adds a markup of 20% in the bills to the project owner.
- The general contractor makes payments to suppliers and subcontractors only after receiving money from the project owner.

One of the questions general contractors have before the construction phase is how much work will be subcontracted out. One of the reasons for subcontracting is to reduce financial burdens [25]. If a portion of a project is subcontracted out under a lump-sum contract, the general contractor may use trade financing to relieve financial burden by speculating a pay-when-paid clause in the contract. To help students understand the impact of subcontracts on cash-flow, different cases with regards to different amounts of work subcontracted were developed, as shown in Table 1.

Table 1. Different Policies on Amount of Subcontracted Work

Case	Labor Cost	Subcontract Cost	Material Cost			
	$	%	$	%	$	%
I	1,400	41.2	1,200	35.3	800	23.5
II	1,800	52.9	800	23.5	800	23.5
III	800	23.5	1,800	52.9	800	23.5

Team Composition and Game Play

Each team in the game is composed of six players. Each student plays a role of a construction project participant: a project owner, a general contractor, a banker, a laborer, a material supplier or a subcontractor. The Cash-flow Simulation Game is to simulate the transfer of resources, such as materials and labor, from project participants to a building (or facility) to be constructed as the project progresses. The resources are represented by different types of stones: laborers by black stones, materials by colorful stones and subcontracted work by white stones, as shown in Figure 2.

Figure 2. Materials needed for the Cash-flow Simulation Game

Each team is provided with information about estimated cost and schedule of work. The information lets the team members know estimated cost, unit cost and schedule of work items for laborer, supplier and subcontractor. The game is to be played in multiple time frames (i.e., weeks). Each player with the role of laborer, supplier or subcontractor should determine the amount of work completed, resources allocated or materials supplied each week by rolling a die. For example, if a player has a two on his or her die, then, two becomes the amount of work completed, resources allocated or materials supplied. Then, the players need to move their own stones, which represent finished work, installed material or allocated labor to the general contractor, or hold the stones until the end of each month depending on the assumptions regarding billing and payment. The player whose role is the general contractor is required to make payments with poker chips to laborers every week and to suppliers and subcontractors every month. At the end of each month, the general contractor bills the project owner based on what has been installed (amount of stones in front of the general contractor) and moves all of the stones to the project owner. Then the project owner makes a payment to the general contractor one month after the billing and holds 10% of the billing amount as retention. When the players of subcontractor, laborer and supplier bill the general contractor, and when the general contractor bills the project owner, they need to calculate the amount of billing based on the number from the dice and the unit cost, and write the amount on a billing sheet. Finally, the billing sheets (bills) are transferred to the general contractor or the project owner along with stones.

The general contractor is required to calculate balance in the cash account at the end of every transaction of poker chips. If the player does not have enough cash for payments, then the general contractor has to borrow poker chips (cash) from the banker. In order to record the balance, the general contractor is given an empty chart for cash balance and has to keep its record. Each round of the game is over when all of the resources (or stones) are transferred to the project owner and all of the suppliers, laborers and subcontractors are paid by the general contractor.

The Cash-flow Simulation Game developed in this study has the following features:

- Simple and easy to follow: this game simply simulates transactions of work, service, materials and cash in real construction projects with stones and poker chips. Therefore, it is very straightforward in visualizing transactions of resources and cash among project participants.
- Minimized calculations: by transferring poker chips (representing cash) and stones (representing resources), the players don't need to calculate the amount of work (service or material) provided every week. Calculation of billing and payment amounts is based on the number of stones in front of the players.
- Easy identification of the maximum amount of cash to be borrowed (or invested): the general contractor needs to keep a record of the cash balance at the end of each transaction on the given sheet. This data on a plot enables the students to easily find the minimum balance or the maximum amount of cash to be borrowed (or invested).
- Consideration of uncertainty in construction execution: amount of work (or service) completed (or provided) and the amount of materials supplied each week are determined by rolling a die. This process reflects the uncertainties in the amount of labor available, construction productivity and material supply.
- Easy comparison of impacts of different policies: the game is planned to be played in three rounds with different policies regarding payment timing and schedule of values. The result in the general contractor's minimum balance from each round can be easily compared from other rounds, and students can identify and discuss the impacts easily.

Implementation of the Game

The Cash-flow Simulation Game was implemented in the Construction Finance and Accounting class in the fall, 2011, semester after a pilot study in the previous semester at one author's institution. A total of 35 students in six teams (5 teams with 6 members and one team with 5 members) participated in the game.

It took about 20-25 minutes to complete one round of the game. All of the six teams finished the first round and recorded the change in the general contractors' balance as exemplified in Figure 3. Then, they could determine the minimum balance (or the maximum amount of cash to be borrowed or invested) from the plot. Also, the students discussed the impact of the amount of subcontracted work on cash-flow based on their plots.

Evaluation of the Game

The Cash-flow Simulation Game was evaluated with regards to its applicability to teaching by a questionnaire survey. This survey was taken and completed by the students who participated in the game. The questions in the survey asked about the students' perception on the helpfulness of the game in their learning. The results are summarized in Figure 4. Based on the results, it can be concluded that the game is helpful for the students to understand the topics related to cash-flow in construction projects and forecasting cash-flow. Positive responses (sum of *Strongly Agree* and *Moderately Agree*) for each question are 100% for typical billing procedures (question 1), 96.97% for *cash trap* (question 2), 69.69% for impact of front-end-loaded SoV on cash-flow (question 3), 93.94% for impact of different policies on cash-flow (question 4), and 96.97% for overall cash-flow (question 4), 72.72% for helpfulness on forecasting cash-flow on spreadsheet software (question 5), respectively.

As for the helpfulness of the game in work on spreadsheet software, the positive response rate was relatively low (around 73%) compared to other questions. One possible reason could be that some students were not familiar with Excel spreadsheets or Excel functions. Other than these two, it can be concluded that the game is very helpful in understanding the topics related to cash-flow. In addition, the following are the students' actual comments on the game.

- *It's a good learning tool to actually see the money being transferred to where it's supposed to go and when.*

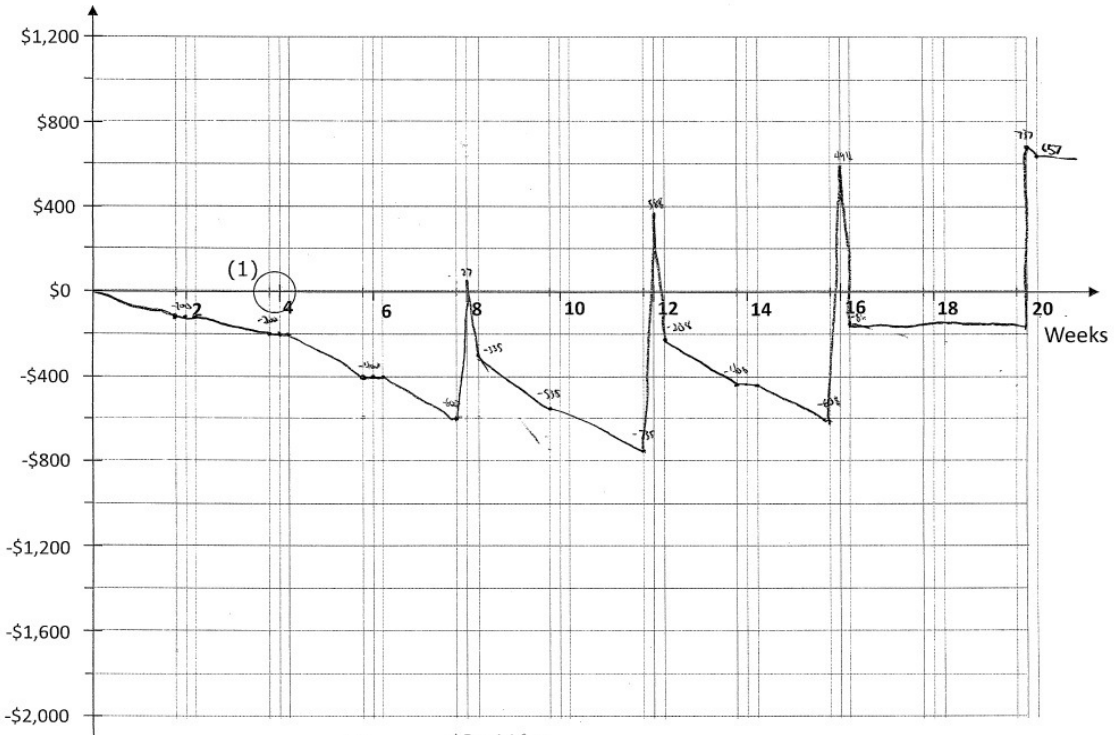

Figure 3. Example of the General Contractor's Balance Record

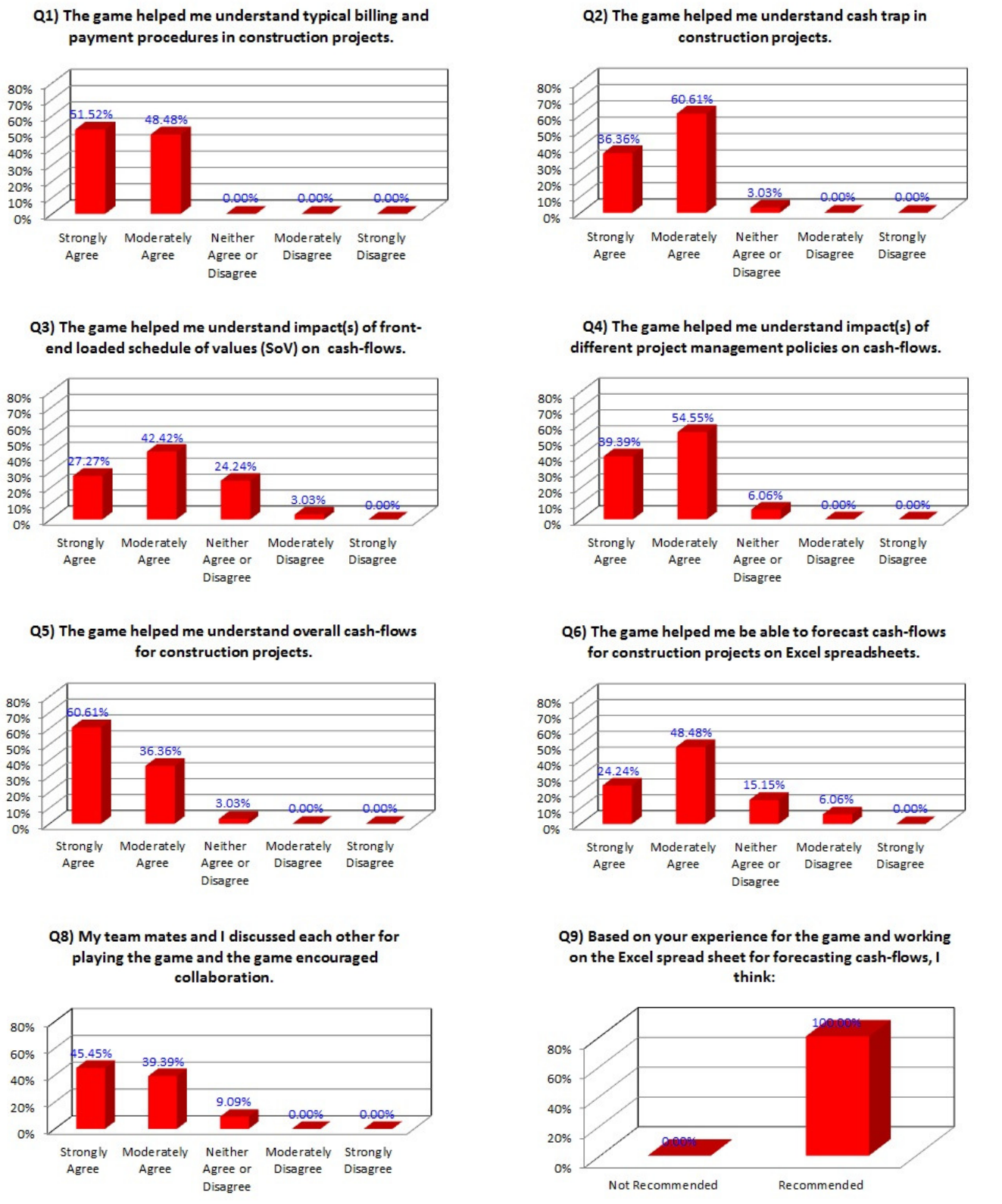

Figure 4. Results of the Questionnaire Survey

- *Great game thanks for coming up with it.*
- *It was fun and it made it easier to visualize the transactions.*
- *Helps with the physical understanding of cash flow.*
- *It's nice to do some hands-on work, and not always just learn from PowerPoint presentation.*
- *I liked the game, helped out a lot.*

This result cannot be a valid assessment of the efficacy of the game in teaching and learning, but it can prove that the game is applicable in teaching how to forecast construction cash-flows. Also, as mentioned in the students' comments, the game is a hands-on activity that is more interesting than a lecture. Therefore, it can motivate the students in quantitative cash-flow analysis on an Excel spreadsheet.

Conclusions and Discussion

Understanding features of cash-flow and prediction of cash-flow in construction projects are very important to construction companies. However, due to the combined impacts of multiple factors on cash-flow, many students in a CM program had a difficult time forecasting cash-flow. To help the students with forecasting cash-flow, the Cash-flow Simulation game was developed. The Cash-flow Simulation Game is to simply simulate transaction of cash as well as resources to help students visualize the actual transfer of cash in construction projects. In addition to the visualization of cash transfer, the students can easily determine the minimum balance of the general contractor (or the maximum amount of cash to be borrowed) from the game without complicated calculations. Furthermore, impacts of different managerial policies with regards to payment timing, schedule of values and amount of work to be subcontracted on cash-flow can be easily recognized from multiple rounds of the game.

The applicability of the Cash-flow Simulation Game was evaluated by a questionnaire survey. Based on the students' perceptions, it was concluded that the game helps students understand the features of cash-flow in construction projects and impacts of different policies on cash-flow. Also, it was determined that the game can facilitate collaboration between students and encourage active learning.

The game is helpful in teaching how to forecast cash-flow in construction projects, but it is not recommended that the game replace more formal approaches such as quantitative cash-flow analysis on an Excel spreadsheet; instead, the game should complement these approaches [17]. And though it was concluded that the game is helpful to student learning, the authors plan to perform a future study on the efficacy of the game in teaching and learning with objective data such as test results. This future research will enhance the reliability of the game for teaching and learning.

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Biographies

EUYSUP SHIM is an Assistant Professor of Construction Management at Illinois State University. He earned his B.S. and M.S. degree (Architectural Engineering, 1996 and 1998) from Yonsei University, South Korea and Ph.D. (Civil Engineering 2008) from Texas A&M University. His research interest is construction project planning and LEAN construction. His email address is eshim@ilstu.edu

BYUNG-CHEOL KIM is an assistant professor in civil engineering at Ohio University. He received his Ph.D. (2007) in civil engineering from the Texas A&M University and M.S. (1995) and B.S. (1993) in civil engineering from the Seoul National University, South Korea. Before his Ph.D. study, he worked for Samsung E&C Corporation for 6 years as a project engineer, bridge design manager, scheduler, and project control manager. He is a registered professional engineer in Ohio, a registered structural engineer in South Korea since 1998, and a PMP (Project Management Professional) certified by PMI since 1999. He has an extensive experience in teaching various CEM related courses, including construction project management, scheduling, cost estimating, project development, equipment, and construction laws. His interest areas are stochastic tools and solutions to project risks, risk-based feasibility analysis, decision making for green buildings, and theories for complex systems.

SEONGCHAN KIM received his Ph.D. in Architecture from Texas A&M University in August of 2006. Dr. Kim has been a faculty member at the Department of Engineering Technology at Western Illinois University since August 2008. His primary research areas of interest include sustainable construction, building energy simulation, building energy code analysis, BIM (Building Information Modeling), energy optimization in building design, and construction process simulation. Before joining Western Illinois University, Dr. Kim held professorial positions at Texas A&M University as a visiting assistant professor and research associate. He performed various funded projects by the Texas State Legislature. He has been involved in various research consultation and presentation. His email address is s-kim7@wiu.edu