

Implementing and Evaluating SilverScreener: A Marketing Management Support System for Movie Exhibitors

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Every Monday morning, Pathé Theaters in the Netherlands decides which movies in its cinemas to retain and which to replace. It must choose replacement movies from those available at that time. We implemented the SilverScreener model, a mathematical-programming system [Swami, Eliashberg, and Weinberg 1999] to help Pathé managers make those decisions for one six-screen theater and tested its performance against the performance of two unaided similar multiscreen cinemas. Using Pathé's historical data, managerial judgment, and theater-specific factors, we developed an attendance-forecasting system. While a fully controlled experiment was not possible, the revenues at the theater using the SilverScreener recommendations were higher than those at the two comparable theaters. Managerial attitudes towards the modeling system improved after implementation of SilverScreener.

In the motion picture industry, marketing-management-support systems (MMSS) have a high potential for helping managers but an unpredictable chance to succeed. While many of the industry's managerial problems are fairly

structured, the decision environment is quite dynamic, contractual arrangements between parties are complex, management turnover is high, and perhaps most important, the cognitive style of the decision makers is often nonanalytical or heuristic

[Wierenga, Van Bruggen, and Staelin 1999]. These characteristics make developing implementable models for decision makers in this industry challenging. Nevertheless, successful implementation of MMSSs in other areas of the arts-and-entertainment industry [for example, Weinberg 1986] made us optimistic about implementing them in the movie industry.

Despite challenges, research on models and decision support systems in the movie industry is emerging. Forecasting, for example, has received an increasing amount of attention. Researchers have reported work on forecasting individuals' enjoyment of movies [Eliashberg and Sawhney 1994] and on the commercial success of movies at the aggregate level [Dodds and Holbrook 1988; Eliashberg et al. 2000; Eliashberg and Shugan 1997; Neelamegham and Chintagunta 1999; and Sawhney and Eliashberg 1996]. Other topics of research and modeling attention include release timing of movies and videos [Kridler and Weinberg 1998; Lehmann and Weinberg 2000; Prasad, Mahajan, and Bronnenberg 1998], assessing the impact of advertising on box-office performance of new films [Zufryden 1996], and designing contracts in a film's supply chain [Swami, Lee, and Weinberg 1998].

The supply chain for movies comprises two key parties: distributor and exhibitor (theater owner). In the US, for instance, there are eight major distributors (such studios as Disney, Universal, and Paramount) and more than 250 exhibitors (for example, Regal, United Artists, and AMC) who own jointly more than 35,000 screens. The number of movies shown annually on these screens is roughly 500. In 2000, they

generated more than \$7.7 billion in US box-office revenues from the sales of approximately 1.5 billion tickets. Most of the movies shown in the US are made by US studios. Foreign-film distributors often do not find screens available for their films. The situation is somewhat different in Europe. Although US films are quite popular there, they compete more intensively for screens with other films. Exhibitors in Western European countries, such as the UK, Germany, France, and Holland, select the movies they show from larger consideration sets that include local, US, and other foreign films.

A theater owner trying to manage screens effectively faces a complex scenario. The complexity comes from various sources. First, the large number of movies available ("Too many pix, too few screens," trumpets a *Variety* 1995 headline) is combined with short and decaying audience appeal over time. Further the owner must decide which films to show for a number of screens in a multiple-screen theater (a multiplex). Second, as distributors release new movies each week, they pressure the owners to provide screens and play time for them. Third, theater owners often base a number of theaters in the same geographical area and must manage the interdependency among several facilities. Fourth, the distributor-exhibitor contract imposes complicating constraints. For example, in the USA, in signing a contract to play a movie in its theaters, the exhibitor becomes obligated to play the film for a certain period of time even when audience demand is weak. The financial arrangements between distributors and exhibitors are unique to

the motion-picture industry. Box-office receipts are split between the distributors and exhibitors such that the split favors the distributor in the first few weeks and favors the exhibitor later on. Distributors thus have a strong incentive to promote the movie intensively in their initial play period. On the other hand, the longer an exhibitor plays the movie, the larger its share of the box-office receipts becomes. At the same time, theater attendance for a movie typically declines the longer it plays. Generally, all concession revenues go to the exhibitor.

The complexity of the screen-management problem means there is a real need for an MMSS that can help theater-programming managers to choose movies optimally for their limited screen capacity. Swami, Eliashberg, and Weinberg [1999] developed such a system, the SilverScreener model. SilverScreener helps managers to select and schedule movies for a multiple-screen theater over a fixed planning horizon in such a way that they maximize the exhibitor's cumulative profit. In an example, they showed in an ex post analysis that if a particular theater in New York City had used SilverScreener, it could have increased its profits by an estimated 38 percent. However, developing a decision-support system is one thing, getting it implemented and used is another [Little 1970; Naert and Leeflang 1978; Wierenga, Van Bruggen, and Staelin 1999]. This is especially true in an environment that traditionally values intuition and creativity more than formal analysis.

Model Implementation Strategy

Our strategy for implementing SilverScreener was guided by Wierenga, Van

Bruggen, and Staelin's [1999] framework, which relates the success of a marketing-management-support system to a number of factors: demand-side factors, supply-side factors, the match between demand and supply, design characteristics of the MMSS, and characteristics of the implementation process (see Figure 1).

The demand side of the MMSS is movie programming at Pathé The Netherlands. In 1999, this exhibitor, headquartered in Amsterdam, asked us to implement SilverScreener for one of its theaters. Pathé The Netherlands (a subsidiary of a French parent company) is the largest movie theater company in the Netherlands and owns a large chain of theaters. In the western part of the country (the Randstad), Pathé is the dominant exhibitor. Pathé's programming department chooses which movies to play in which theater(s) and on which screens each week. It makes these decisions centrally in Amsterdam week by week for all the Pathé theaters in the country. The department is in constant touch with distributors about new movies that will be released, the availability of copies of movies, rental terms, possible slots for movies in theaters, and so on. In the Netherlands, a new movie week starts every Thursday. Every Monday morning a team of three people meets and prepares a movie-allocation schedule for all the Pathé screens in the country for the following movie week, effective the next Thursday. Pathé chose the theater Buitenhof in The Hague for the SilverScreener implementation. Buitenhof is a middle-sized theater with six screens, ranging from 113 to 434 seats, and it is one of the three theaters Pathé owns in The Hague. The Buitenhof

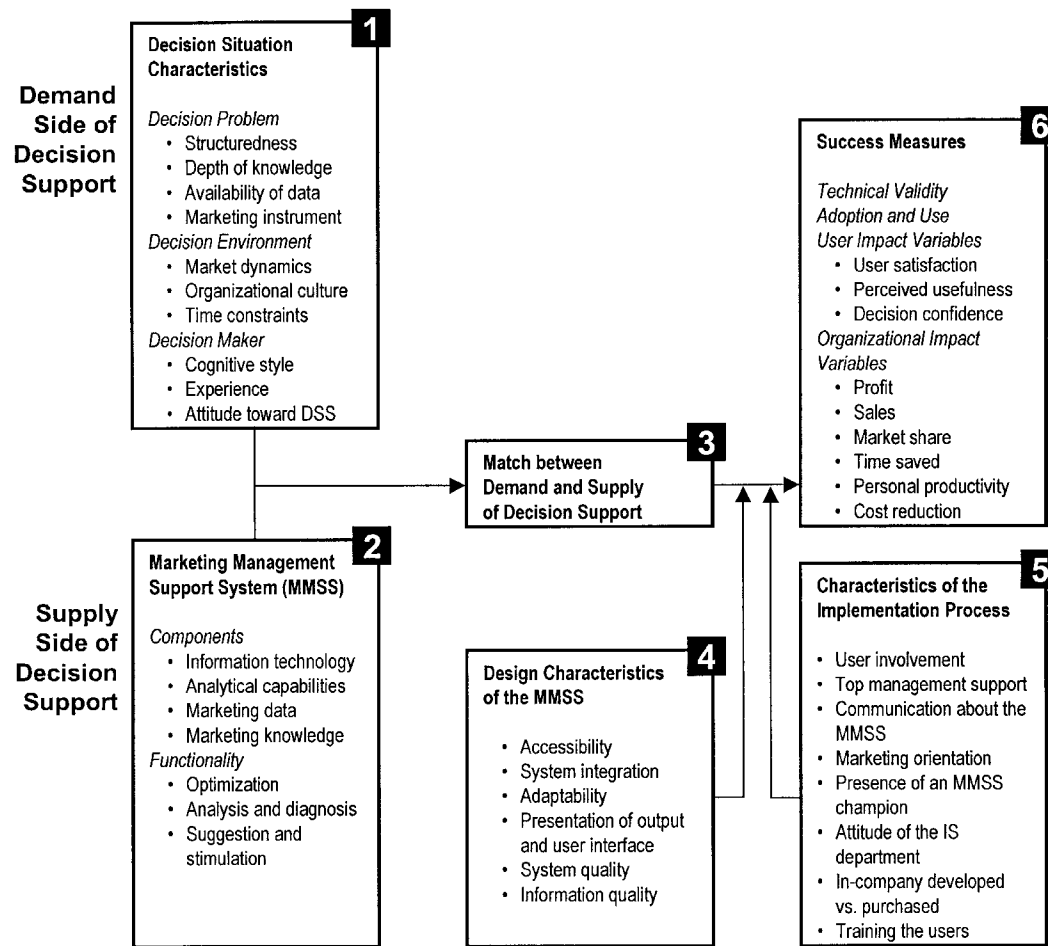


Figure 1: The success of a marketing-management-support system is dependent on a set of factors that can be summarized in an integrated framework.

theater had been renovated in 1996 and Pathé management wanted to give it a further boost by optimizing the movie programming.

Using Wierenga, Van Bruggen, and Staelin’s framework, we developed the following implementation strategy for the SilverScreener MMSS:

- (1) We chose an environment in which managers had a fairly favorable initial attitude towards an MMSS.
- (2) We believe an excellent technical match was made between the decision

problem and the MMSS.

- (3) Because the managers had little experience with models (and analytical methods in general), we operated the MMSS externally.
- (4) We made the SilverScreener’s recommendations instantly accessible through the Internet to the decision makers and presented them in a user-friendly way.
- (5) We maintained constant contact with the users during the implementation process.

- (1) Users’ attitude towards the MMSS

(in this case SilverScreener) is an important determinant of its success (Figure 1). We thought Pathé The Netherlands would make a good client for SilverScreener. Two of the three members of the Pathé programming team had participated earlier in the successful implementation of another

The financial arrangements between distributors and exhibitors are unique to the industry. In movie scheduling, time is of the essence.

MMSS, the Moviemod model [Eliashberg et al. 2000]. Moviemod is a decision-support system that forecasts attendance for new movies prior to their release. Because of its success, the team members had a positive attitude towards MMSSs in general. Their positive attitude towards the system was an important factor, because their cognitive style, another relevant characteristic, was not so favorable. One member of the team made it very clear that he had no trust whatsoever in mathematical models, but he had a very good intuitive feel for which movies would be successful and which would not. One of the other members of the team was more analytical, and one fell in-between. We monitored the attitudes of these SilverScreener users over time by administering an attitude scale three times during the implementation period.

(2) Choosing what movies to program is a fairly structured problem, and the movie industry is data rich, a situation favorable for an optimization model. This is the supply side. SilverScreener models the

movie-programming problem in terms of (decision) variables and relationships and is able to find the optimal solution. This technical match is a favorable condition for implementation, but not a guarantee of success.

(3) The (analytical) SilverScreener approach was new to the Pathé organization, and the team of decision makers had a mixed composition regarding cognitive styles. Because the decision makers experience with analytical methods was limited, we decided that they would not operate SilverScreener themselves. The technical barriers would prevent successful use. Therefore, we carried out the weekly SilverScreener runs and made recommendations to Pathé's programming team. We thought that this way of operating best fit the demand side.

(4) The demand-side factor time constraints is very important to movie scheduling at Pathé. Every week we got new information from the market (ticket sales, movie releases), and we had to prepare a new recommended schedule for the programming team before its weekly programming session. Therefore we relied heavily on the Internet. We were able to run the model remotely because we could transfer input and output data for SilverScreener globally, instantly, and virtually without cost. In terms of design of the MMSS, we made results immediately accessible to the users, presented as directly implementable recommendations. In addition, one of us was located in Holland, which facilitated personal interaction.

(5) User involvement is important to implementation of an MMSS (Figure 1).

Throughout the process, we directly involved the users of SilverScreener, interacting with them online. Another factor that can contribute to the success of an MMSS is the presence of an MMSS champion. In this case, one member of the programming team was a great believer in the value of SilverScreener for Pathé. She put a lot of effort into obtaining the data needed to run the model and into bringing the SilverScreener results to the attention of the other team members every Monday morning.

The Modeling Framework

We formulated the exhibitor's problem as an integer-programming model, which is a special case of the SilverScreener model [Appendix or Swami, Eliashberg, and Weinberg 1999]. For each movie available to Pathé, the team had to decide whether to schedule that movie and, if so, for how many weeks. Using the rolling-horizon approach in the model, each week Pathé team selected the movies (six in the case of the Buitenhof) that would optimize its results over the next eight weeks. However, the team implemented the model's recommendation only for the first week. In the following week, with a revised data set, we reran the model with an eight-week horizon set one week ahead. This approach allowed Pathé to consider the long-run implications of its choices while still allowing it to base decisions on the most recent data (about ticket sales, movie availability, and contract terms). We coded the model in AMPL [Fourer, Gay, and Kernighan 1993], a modeling language for mathematical programming.

The Screen-Allotment Heuristic

Each week, SilverScreener recommends

Screen	1	2	3	4	5	6
Capacity	434	342	216	151	139	113

Table 1: Within the Buitenhof theatre, the six screens have different seating capacities.

a set of movies but not the screens on which they should play. Since the six screens at the Buitenhof theater have different seating capacities (Table 1), we assigned movies to screens according to the following simple heuristic: Each week, allocate the movie with highest expected number of visitors to the highest capacity screen, the movie with the next highest estimated number of visitors to the next highest capacity screen, and so on. The screen-allocation heuristic follows managerial decision practices. Sellouts of movies in the smaller screening rooms are unusual.

Exhibitor's Profit Margin

The profit margin, R_{jiw} , generated by Movie j if it plays for i weeks starting in Week w is the sum of two components—(1) concession profits (popcorn and soft drink sales) and (2) the exhibitor's share of the movie's box-office gross revenue. The exhibitor's share is the percentage of the box-office revenue remaining after paying the distributor's share (rental cost) and taxes (about 10 percent of box-office receipts). The exhibitor's share varies from movie to movie and is generally higher the longer the movie plays at the theater.

$$R_{jiw} = \sum_{u=w}^{w+i-1} POP_{ju} + EXSHARE_{ju}$$

$$*GROSS_{ju}, j = 1, \dots, N, i = 1, \dots,$$

$$d_j - r_j + 1, w = r_j, \dots, d_j - i + 1, \quad (1)$$

where

POP_{ju} = concession profits generated by Movie j in Week u ,

$GROSS_{ju}$ = box-office gross revenue generated by Movie j in Week u , and
 $EXSHARE_{ju}$ = exhibitor's share of the box-office gross revenue of Movie j in Week u .

The exhibitor's share, $EXSHARE_{ju}$, is specified by the contract terms between the distributor and the exhibitor. Both POP_{ju} and $GROSS_{ju}$ are directly proportional to the corresponding number of visitors to the theater. The number of visitors is determined by the demand function.

The Demand Model

Consistent with the empirical results reported by Jedidi, Krider, and Weinberg [1998], Krider and Weinberg [1998], Sawhney and Eliashberg, [1996], and Swami, Eliashberg, and Weinberg [1999], we used an exponentially declining demand curve to estimate the number of visitors attracted by a movie. In addition to the two parameters (accounting for opening and decay rates) usually included in the demand model in the above studies, we incorporated a separate (dummy) variable to account for the effects of holidays. We modeled visitor demand of movie j in week u as the following three-parameter exponentially declining function.

$$\text{Demand} = VISITOR_{ju} = \alpha_j e^{\beta_j u + c_u H_u + \varepsilon} \quad (2)$$

where $\alpha_j > 0$ and $\beta_j < 0$ are opening and decay factors for Movie j ,

$$H_u = \begin{cases} 1, & \text{if } u \text{ is a holiday week,} \\ 0, & \text{otherwise,} \end{cases}$$

c_u is the holiday factor for Week u , and $\varepsilon \sim \text{normal}(0, \sigma^2)$.

We proposed this demand model at a general level of specification. In practice, a movie's run may not include a holiday, and a season may contain only a few

holidays, with the respective factors being H_1, H_2, H_3 , and so on. Moreover, if these holiday factors are manager specified, possibly from past experience or a previous data set, they can be applied directly on a data series, thus requiring only a two-parameter estimation (α and β) of equation (2). In this case, we would first deseasonalize the data series by dividing the data of the week for which the holiday factor is available, then estimate the reduced two-parameter exponential model for the future, and multiply the holiday weeks again by their respective factors. We followed this approach in the Pathé application.

Implementing SilverScreener at Pathé The Netherlands

After some preliminary work starting in the early fall of 1999, we first implemented the model on a regular weekly basis using the rolling-horizon approach in the 45th week of that year. In the last two weeks of 1999, the manager primarily responsible for SilverScreener went on holiday, and thus the schedule in the Buitenhof remained unchanged in Weeks 51 and 52. Data were not available for the SilverScreener project until the third week of 2000; we resumed making recommendations in the third week of 2000. Pathé continued to use the SilverScreener model until May 2000.

Data and Managerial Estimates

In fall 1999 (Week 40 of the year), Pathé management provided us with the following data with respect to the Buitenhof theater:

—A list of movies and release dates for the second half of 1999 and an indication of movies to be considered for Buitenhof;

—Data on the genres to which movies belong, that is, drama, fiction, comedy, or action;

—Data from which to estimate the expected demand for each new movie using case-based reasoning, that is, by drawing analogies from previous movies [Kolodner 1993; Leake 1996] (For a new movie, management identified a “matching” movie or movies in the historical data base, based on genre and other characteristics, on which to estimate opening strength and decay rate, and typically provided estimates of movie revenues for the first three weeks of its showing);

—Performance data (for Weeks 27 through 39) for all movies that played at Buitenhof prior to Week 40, including the week of the year, screen number, movie title, actual number of visitors, total box-office receipts, net receipts after taxes (the taxes are approximately 10 percent of total box-office receipts), and rental fees to the distributor based on the sharing percentages specified in the contract (Table 2).

The consideration set of movies consisted of the movies already released and the movies expected to be released during the implementation horizon (Table 3).

Thus, at Week 40, for instance, the set included the movies released between Weeks 27 and 39 and the movies slated for release between Weeks 40 and 52. The consideration set is dynamic and flexible. In a particular week, the distributor may decide to postpone a movie that was to be released that week, or movies may be released ahead of the scheduled release date. Moreover, a new movie may unexpectedly become available in a particular week. Two movies that were screened at Buitenhof unexpectedly became available in late 1999. Table 3 shows the complete consideration set of movies in the course of this study from Week 40 until Week 52.

Sequencing Information Flows and Decisions

The timing of events was of immense importance in this application: when and how we obtained data, how long we took to prepare and communicate recommendations, when the team made decisions, and when and how it sent feedback to us (Figure 2). In this implementation project, the research collaborators were based in the US, India, Canada, and the Netherlands. Communication among the researchers and with Pathé took place

Week	Screen number	Title	Number of visitors	Total box-office receipts	Net receipts after taxes	Film rental to distributor
9942	1	Star Wars Episode 1	4,878	65,247	61,648.83	30,824.40
	2	The Haunting	3,555	48,528	45,781.32	22,890.70
	3	Runaway Bride	1,245	17,196	16,222.71	6,489.08
	4	Austin Powers 2/Spy	459	6,136	5,788.70	1,736.61
	5	Big Daddy	1,647	21,081	19,888.28	7,955.32
	6	Tea With Mussolini	339	4,708	4,441.53	1,776.61

Table 2: Each week, detailed attendance and revenue data are available for each screen at the Buitenhof theatre.

Movie number	Title	Movie number	Title
1	Notting Hill (NH)	18	Star Wars Epis. 1 (SWE1)
2	Cruel Intention (CI)	19	Inspector Gadget (IG)
3	The Matrix (TM)	20	Tea with Mussolini (TWM)
4	Existenz (EXIS)	21	Instinct (INSTINCT)
5	She's All That (SAT)	22	Out-of-Towners (OOT)
6	Ed TV (ED)	23	The Haunting (TH)
7	The Mummy (MUMMY)	24	Big Daddy (BD)
8	Sliding Doors (SD)	25	Do Not Disturb (DND)
9	Never Been Kissed (NBK)	26	Random Hearts (RH)
10	Thomas Crown Affair (TCA)	27	General's Daughter (GD)
11	Analyze This (AT)	28	Mickey Blue Eyes (MBE)
12	Wild Wild West (WWW)	29	Disney's Tarzan (DT)
13	Eyes Wide Shut (EWS)	30	James Bond: Twine (JBT)
14	Runaway Bride (BRIDE)	31	End of Days (EOD)
15	Austin Power 2/Spy (AP)	32	Bowfinger (BOWF)
16	Office Space (OS)	33	Deep Blue Sea (DBS)
17	The Squad (SQUAD)	34	Blue Streak (BS)

Table 3: Management had 34 movies in their consideration set for Weeks 40 to 52.

through the Internet.

Since at Pathé new movies start their runs on Thursdays, we defined a Movie Week as the period from Thursday through the following Wednesday. The team makes replacement decisions for the upcoming Movie Week ($t + 1$) on the previous Monday morning. Pathé collects performance data (Table 2) for the previous Week ($t - 1$) on Thursday of the current Movie Week, and sends it on Friday for analysis. It also sends the schedule of the movies playing in the current week (t).

Figure 2 shows the occurrence of different events for Movie Weeks 45, 46, and 47 in 1999. As shown in the figure, Pathé implements a new movie schedule at the beginning of a Movie Week (for example, Thursday of Week 45 = t). On Friday, Pathé receives the performance data for Movie Week 44. On the same day, these data are compiled and sent with the actual schedule for Movie Week 45 to the model

analysis location. We then analyzed the data for model implementation and developed and communicated scheduling recommendations for managers' consideration in making Monday-morning replacement decisions. Each week, we had only two days over the weekend to analyze data and develop recommendations.

Exhibitor's Profit Margin

To estimate R_{jw} , the profit margin a movie j generates for the exhibitor if it plays for i weeks starting in week w , we need estimates of $GROSS_{jw}$, POP_{jw} , and $EXSHARE_{jw}$ (equation (1)), calculated appropriately over i weeks. Starting with the number of visitors for movie j in week w , $VISITOR_{jw}$, we estimate the corresponding revenue, $GROSS_{jw}$, that the movie generates for Pathé as follows:

$$GROSS_{jw} = ATP * VISITOR_{jw} * \text{Tax Deduction Factor} \quad (3)$$

where ATP is the average ticket price at

SILVERSCREENER

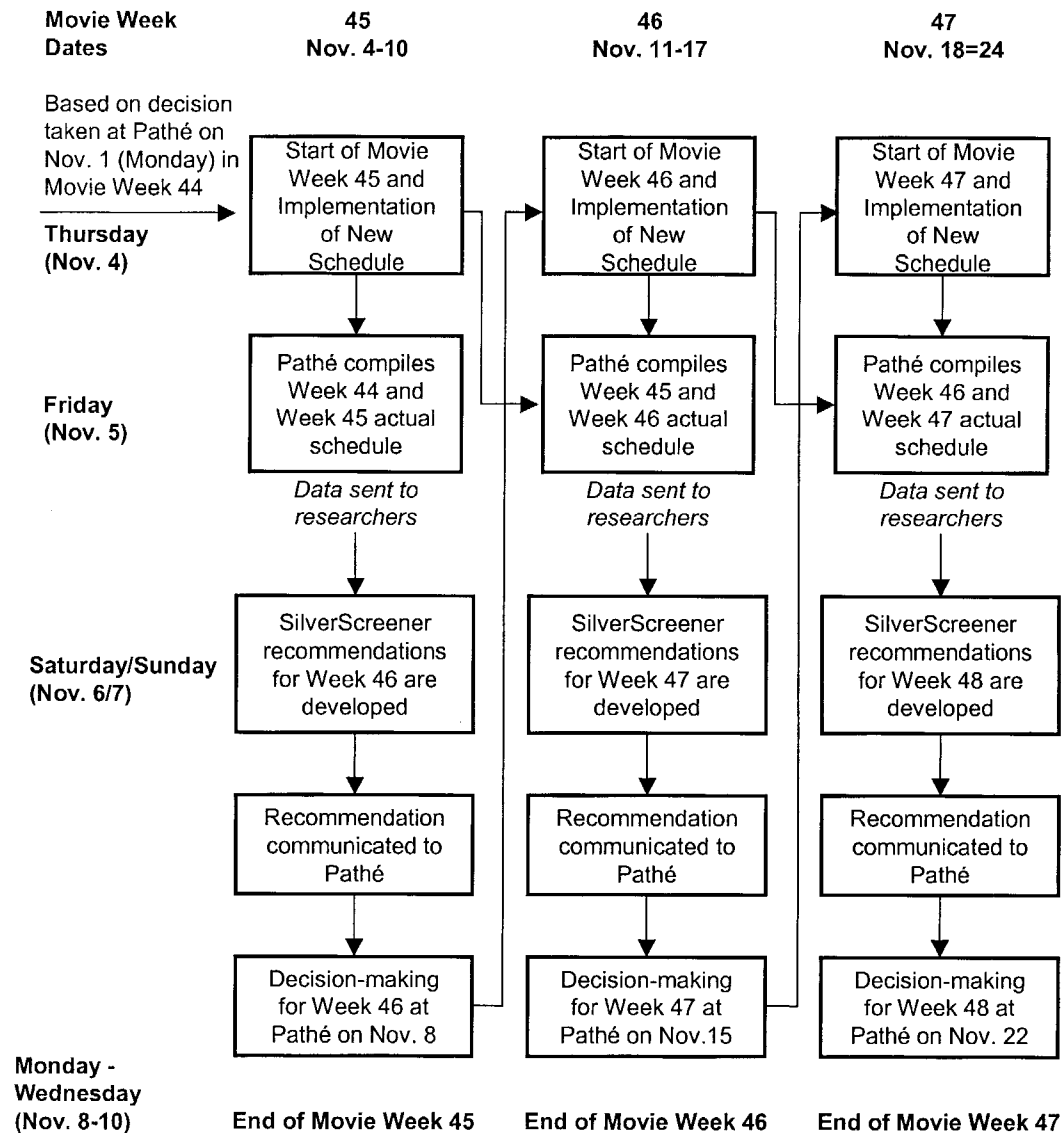


Figure 2: The transmission of data and recommendations had to be coordinated to ensure that timely information was provided to theater management.

Pathé and is estimated to be Dfl 13.5 and the tax deduction factor is 0.89725.

We estimate the corresponding profit contribution from concessions, POP_{jwr} as follows:

$$POP_{jw} = \text{Average Concession Profit} \times \text{Contribution Per Visitor} * VISITOR_{jwr} \quad (4)$$

We estimate the average concession profit per visitor at Pathé to be Dfl 2.00.

We estimate contract terms, $EXSHARE_{jwr}$ as follows:

—For movies that have played for some weeks, we generally found that by the end of the contract stream, the distributor's share stabilizes at 27.5 percent. Accord-

ingly, we used this heuristic: If the contract term for the actual run ends at 27.5 percent, stabilize it at 27.5 percent for the coming weeks, otherwise, use the contract terms of the analogous movie from the previous year's data.

For future releases, we classify movies as Type A, B, or C, depending on the attendance expected. For example, if the weekly number of visitors is expected to consistently exceed 1,000, it is Type A, and if the number is below 500, it is a Type C. The contract terms vary for the three types of movies. For Type A movies, the distributor retains 60 percent of box-office receipts in the first week, 50 percent in the second week, and 40 percent in the third week. For Type B movies, the corresponding shares are 50 percent, 40 percent, and 40 percent for each of the first three weeks; for Type C movies, 40, 30, and 30 percent. For all types of movies, from Week 4 on, the distributor's share declines by 2.5 percent per week until it stabilizes at 27.5 percent. The contract terms (which the distributor sets) are based on the fact that Type A movies have the highest opening attendance (high α) and retain high attendance (low β), at least in the initial few weeks (for example, *James Bond: The World is Not Enough* and *Disney's Tarzan*). For such movies, the distributor wants as large a share of box-office revenue as possible in the initial weeks of their run. Type C movies (for example, *Lake Placid*), on the other hand, do not perform well on either opening or decay rates (low α and high β), and accordingly, the distributor does not mind starting with a lower share (40 percent). Type B movies (for example, *Bowfinger*) are in the middle,

with their demand parameters between those of Types A and C. The distributor designs the contract terms to be somewhat attractive to both distributor and exhibitor.

Demand Estimation

To estimate $VISITOR_{jw}$, the demand for movie j in week w (equation (2)), we estimate the opening and decay parameters, α_j and β_j , and the holiday factor, c . During the initial implementation period of SilverScreener (Weeks 40 to 52), there were only three holiday weeks: Weeks 42 and 43 (autumn vacation) and Week 52 (Christmas holiday). We estimated the opening and decay rates of a movie by transforming the three-parameter model into a two-parameter exponentially declining model, which involves only opening and decay rates. Then we multiplied the revenues of the movies in the holiday weeks by their holiday factors, which we estimated independently.

During any movie week, some of the movies in the consideration set have already been released, while some are scheduled for release. To estimate demand for a particular movie, we consider three different points on the decision-making time line and the source of the data used for estimation.

The first point is before the movie's release. With no actual data, we use only the managerial estimates. The next point is when we have data on the initial week's showing. Since we need at least one more data point to estimate a two-parameter model, we use the first week's actual data and the manager's estimates for the second week onwards, employing a combination of managerial estimates and actual data. The third point is when the movie

has been playing for at least two weeks. In this case, we have data to estimate a two-parameter model, and we use only the model-based estimates.

Based on this explanation, we divide our method of forecasting future demand at Pathé into two parts:

—For movies already released, we use the two-parameter exponentially declining model by log-transforming equation (2) and fitting a regression model. This requires actual data for at least two weeks. For the movies for which we have only one week's data, we use the first week's actual sales and managerial estimates for later weeks. We generate regression-based estimates to forecast attendance for the later weeks.

—For forthcoming movies, we use the following procedure:

- (1) If the manager's estimates follow a consistently decreasing pattern for the first three weeks of the movie's run, we use the regression model version of equation (2) using the three data points to forecast demand from Week 4 onwards.
- (2) If the manager's estimates do not decrease consistently, we use the estimates for the first three weeks. To forecast demand from Week 4 onwards, we use the decay factor of the matching movie from the previous year's data (and an opening rate based on the last managerial estimate).
- (3) If managers provide no matching movie, we follow a procedure similar to (2) except that for the decay factor we use the average of the decay factors of all the movies in the previous year's data.

We designed our estimation procedure to suit the model-implementation situa-

tion. The key feature is that we give priority to different data types according to their origins: first, the most recent actual box-office data; second, managerial estimates; third, estimates drawn from a matching movie from the previous year; and fourth, average data from the previous year.

We use this order to reflect these measures' value as indicators of audiences' reactions. Previous studies have demonstrated the validity of using actual box-office data [Jedidi, Krider, and Weinberg 1998, Lehmann and Weinberg 2000, and Sawhney and Eliashberg 1996]. The next best option is to use managerial estimates for the current year since managers know the situation and can rely on their experience in the movie business and at the particular theater chosen. By using the manager's estimates for only the first three weeks and using them in an analytical model, we blend managerial estimates with an established and validated forecasting approach. The third option is to rely on data from a matching movie from the previous year, also specified by the manager. This procedure has merit in that the manager refers to the movie's attributes and to historical data that shows the reaction of that theater's moviegoers. We rely on the last option, using average decay rate from the previous year, when the manager cannot pinpoint a matching movie from the previous year. To still extract information from the company's historical database, we use the average for all the movies that played at the theater as an initial estimate.

In a previous study, Swami, Eliashberg, and Weinberg [1999] combined the

matching-movie and average-decay-rate approaches by using a set of attributes of the movie, such as genre and MPAA rating. Their attributes were based on previous studies, such as Wallace, Seigerman, and Holbrook [1993], Sawhney and Eliashberg [1996], and Jedidi, Krider and Weinberg [1998].

Estimating Demand for Reruns

Theaters show most movies continuously for some time. Occasionally they run some movies for several weeks, stop, and then resume playing them after a break of a few weeks (reruns). To estimate demand in such cases, we increased the counter for the week number in equation (2) even during the intermittent weeks in which the movie was not shown.

Treatment of Holiday Factors

Weeks 42, 43, and 52 were holiday weeks during the 1999 implementation period. We had to estimate holiday factors for those weeks. At the beginning of the project, Pathé provided us with data for the same theater for the first 26 weeks of

1998, during which there were five holidays: Week 8 (spring vacation), Week 15 (Easter), Week 18 (the Queen's birthday), Week 21 (Ascension Day), and Week 22 (Pentecost). The values for the holiday factors based on 1998 data are $\exp(c_8) = 1.47$, $\exp(c_{15}) = 1.82$, $\exp(c_{18}) = 1.92$, $\exp(c_{21}) = 2.37$, and $\exp(c_{22}) = 1.42$.

The manager thought that c_{42} and c_{43} in 1999 were likely to be similar to c_8 in 1998, and that c_{52} in 1999 was likely to be similar to c_{21} in 1998. To "de-holiday" the data for estimation purposes, we multiplied the demand estimates given by the two-parameter exponential model (considering opening and decay rates) by 1.47 for Weeks 42 and 43, and by 2.37 for Week 52 of 1999.

Implementation Results

Starting in Week 43 of 1999, management at the Buitenhof received weekly SilverScreener recommendations, so the actual schedule from that point onwards reflects management's response to these recommendations (Table 4). No recom-

Week\Screen	1	2	3	4	5	6
40	SWE1	BRIDE	AP	MUMMY	EWS	SQUAD
41	SWE1	BRIDE	TWM	MUMMY	AP	OOT
42	SWE1	TH	BRIDE	AP	BD	TWM
43	SWE1	TH	BRIDE	AT	BD	TWM
44	SWE1	TH	DBS	BRIDE	BD	AT
45	DND	DBS	RH	TH	SWE1	BRIDE
46	GD	DBS	SWE1	DND	RH	BRIDE
47	DT	DBS	GD	RH	SWE1	BRIDE
48	DT	DBS	BS	SWE1	GD	BRIDE
49	BS	DT	DBS	GD	SWE1	JBT
50	BS	DT	DBS	GD	SWE1	JBT
51	BS	DT	DBS	GD	SWE1	JBT
52	BS	DT	DBS	GD	SWE1	JBT

Table 4: Each week, management chose which movies to show as can be seen in the Buitenhof's actual schedule.

mendation could be made in Week 44 because of data-communication problems. Table 5 presents each week’s recommendation following the SilverScreener approach.

The face validity of our recommended schedules was very high. Typically, at least five of the six recommended movies in a week matched the actual schedule. Differences were sometimes caused by last-minute changes in availability. In Week 45, for example, the only difference is that DBS was in the actual schedule, whereas BD was in the recommended schedule. However, DBS entered the consideration set at the last moment, the manager having decided to play it in the Buitenhof because of its success at another theater. By the next week DBS had entered the consideration set and its continuation was recommended.

Contingency Schedules

A specific element that Pathé takes into account that was not an element of SilverScreener is the possible effect a movie choice for Buitenhof could have for Pathé’s other two theaters in The Hague:

Metropole and Scheveningen. For example, sometimes the number of available copies of a particular movie is limited. Using a copy for Buitenhof could mean none would be left for Metropole. At other times, the decision is driven by more strategic considerations. Despite SilverScreener’s recommendation, the manager decided not to play *Mickey Blue Eyes* in Buitenhof because “we have decided to play *Mickey Blue Eyes* at Metropole as it was urgently in need of a new movie.”

SilverScreener considers a stand-alone theater and does not take into account interdependencies among theaters. To accommodate management’s needs, we added a contingency option for Pathé. This option determines the best schedule if the first, second, and third best movies are removed from consideration at the Buitenhof. These contingency schedules, which took seconds to run on a computer, were considered to be extremely helpful by management.

The Success of the SilverScreener Implementation

The marketing-management-support

Week\Screen	1	2	3	4	5	6
43	SWE1	TH	BD	EWS	BRIDE	TWM
44	*	*	*	*	*	*
45	SWE1	RH	TH	BRIDE	DND	BD
46	GD	SWE1	RH	TH	DBS	DND
47	MBE	GD	DBS	DT	SWE1	RH
48	DBS	GD	SWE1	DT	BRIDE	IG
49	JBT	BS	DT	SWE1	DBS	GD
50	JBT	EOD	DT	SWE1	BS	DBS
51	JBT	DT	EOD	DBS	BS	BOWF
52	JBT	DT	EOD	DBS	BS	BOWF

Table 5: Each week, aside from week 44 when a recommendation could not be made due to data communication problems, SilverScreener recommended which six movies should be played.

system succeeded in satisfying multiple criteria (Figure 1). The first is technical validity. Based on Swami, Eliashberg, and Weinberg [1999] and numerous test runs, we are confident that SilverScreener accomplishes its goals in a timely and efficient manner. The second criterion is implementation success, whether the decision maker adopted and used the MMSS. Pathé used SilverScreener every week. Once, because of a transmission problem, the recommendations came late and the people at Pathé missed seeing the current recommendation. They had to rely on the previous week's recommendations for the second week, which was still useful since it included suggested schedules several weeks ahead. So, on this count, SilverScreener was a success. The next two levels on which the success of an MMSS can be measured are impact for the user (satisfaction, perceived usefulness) and impact for the organization (sales, profits).

The Impact of SilverScreener on Sales and Profits

The objective of SilverScreener is to maximize the exhibitor's cumulative profits over the planning horizon. In 1999, the implementation period for the theater Buitenhof was the last 10 weeks of the year, Week 43 through Week 52. We also have data for the first eight weeks of 2000.

We followed the adaptive decision-making approach for the 10 time windows in 1999. To see how well Buitenhof The Hague did, given SilverScreener's recommendations, we compared its results with two other Pathé theaters with somewhat comparable positioning in terms of movies and audience: Pathé-Rotterdam and Pathé-Groningen. For these theaters, we have

data on weekly tickets sales for 1999 and 2000.

We analyzed sales weekly, looking at attendance at each theater. Our preliminary analysis indicated no significant difference in profitability (as distinct from sales) of the three theaters (the profit data are confidential).

While we started interacting with Pathé in Week 40 and proposed a schedule for Week 43 (but not for Week 44 because of start-up difficulties), our regular ongoing communication on scheduling began in Week 45. At this time, management actively reviewed the SilverScreener recommendations. During Weeks 51 and 52, several members of the management team were away on Christmas holiday and they set the schedule for Weeks 51 and 52 to be basically the same as that for Week 50. We did not run SilverScreener for Weeks 51 and 52 of 1999 or for Weeks 1 and 2 of 2000. We began weekly SilverScreener runs again in Week 3 of 2000.

We compared the three theaters for the 1999 effective implementation period from Weeks 45 through 52, calculating the percentage change in the number of visitors from 1998 to 1999 at the three theaters (Table 6). All three theaters showed periodic changes from one year to the next. Attendance at the Buitenhof improved more than that for the other two theaters for Weeks 45 through 50, although their performances improved in Weeks 51 and 52.

The managers' review of SilverScreener at the start of 2000 was favorable, and they wanted to continue using the model. While communication problems interfered with our gathering data and reporting recommendations at the start of the year, by

Week\ Theater	Buitenhof	Rotterdam	Groningen
45	2.92	-9.53	-5.43
46	-5.92	-18.55	-12.10
47	-9.13	-6.26	-17.55
48	10.14	-2.36	-10.65
49	57.53	44.47	52.80
50	43.95	42.41	23.30

Table 6: The weekly percentage change in number of visitors in 1999 as compared to 1998 was typically greater at the Buitenhof than at two comparable theaters.

Week 3 of 2000 the multicontinent SilverScreener implementation was fully operational again.

For the first eight weeks of the year we continued to gather comparative data for the three Pathé movie theaters. We ranked the three theaters by percentage change in attendance for each of the 14 weeks in our sample (omitting the Christmas holidays) (Table 7). Of the 14 weeks of the compari-

son, the Buitenhof theater ranked first for nine, second for three, and third for two of the weeks analyzed. In the two weeks in which it ranked third, no SilverScreener recommendation was available for the Pathé managers (the first two weeks of 2000).

For the first 42 weeks of 1999, the cumulative attendance at the Buitenhof decreased by 6.1 percent. For the last 10 weeks of the year, cumulative attendance increased by 10.3 percent compared to the previous year. This improvement, while most likely driven by other factors in addition to the SilverScreener implementation, may have helped to persuade management to continue using the SilverScreener system.

Managerial Perceptions of the Effect of SilverScreener

We measured the attitudes of the members of the programming team towards

Week (Year)\Theater	Buitenhof	Rotterdam	Groningen
45 (1999)	1	3	2
46 (1999)	1	3	2
47 (1999)	2	1	3
48 (1999)	1	2	3
49 (1999)	1	3	2
50 (1999)	1	2	3
51 (1999)	Christmas Holiday	Christmas Holiday	Christmas Holiday
52 (1999)	Christmas Holiday	Christmas Holiday	Christmas Holiday
01 (2000)	3*	2	1
02 (2000)	3*	1	2
03 (2000)	1	2	3
04 (2000)	1	3	2
05 (2000)	1	Film Festival	2
06 (2000)	2	1	3
07 (2000)	2	3	1
08 (2000)	1	3	2

Table 7: The weekly ranking of theaters based on year-to-year changes in number of visitors showed that the Buitenhof generally performed better than two comparable theaters, recognizing that no SilverScreener recommendations were available for the first two weeks of 2000.

SilverScreener, using three items from a scale Schultz and Slevin [1975] developed to measure peoples' attitudes towards an information system. We administered the scale three times: before the team used SilverScreener recommendations (Week 42), after the first effective implementation period (Week 49), and after a change in management early in 2000 (Week 13) (Table 8).

For all the managers involved, attitudes towards SilverScreener (which started at a not-too-unfavorable level) generally improved over time. The manager who was most skeptical about the MMSS to begin with (Manager 3) took the longest time to change his attitude but finally reached the same score as the MMSS champion (Manager 1). Interestingly, the champion, even more than Manager 2, questioned whether SilverScreener would make her decisions easier. The new senior manager, who

joined the team after the retirement of Manager 2 in early 2000, started with a favorable attitude. This might be because people in the company talked about the system in positive terms.

The managers apparently have an increasingly positive perception of SilverScreener's contribution. However, they do not follow SilverScreener's recommendations blindly, realizing there can always be considerations that overrule its advice. Asked to estimate the influence of SilverScreener's recommendations on the ultimate decision, Manager 1 mentioned a percentage of 70 percent.

New Manager and New Theater

The new senior manager has a positive attitude towards the SilverScreener system. She has urged the SilverScreener team to continue making recommendations.

In 2000, Pathé opened a new, very large theater with 14 screens near the new soc-

	Manager 1			Manager 2		Manager 3			New
	Wk 42/99	Wk 49/99	Wk 13/00	Wk 42/99	Wk 49/99	Wk 42/99	Wk 49/99	Wk 13/00	Wk 13/00
Item 1 I think that movie-planning decisions will be easier when using SilverScreener	2	2	3	3	3	2	3	3	3
Item 2 I think that movie-planning decisions with SilverScreener will be better	3	3	4	3	4	2	2	4	3
Item 3 I expect to be able to improve my movie-planning decisions using SilverScreener	4	4	4	4	4	4	3	4	4
Sum	9	9	11	10	11	8	8	11	10

Table 8: Management attitudes toward the use of SilverScreener, measured on a scale from 1 = strongly disagree to 5 = strongly agree, improved over time.

cer stadium arena in Amsterdam. It has asked the SilverScreener team to take on the programming for this theater.

Conclusions

Our adaptation of the published version of SilverScreener served Pathé well, but in the long run, we will likely have to treat the multitheater case more formally if Pathé is to adopt the system across its chain of theaters. Also, for Pathé to continue to use the MMSS successfully, we will have to transfer the operation of SilverScreener to Pathé's managers. One reason we conducted this study was to learn what was required for a successful implementation. We need to develop a user-friendly version (including automatic entering of box-office results and automatic forecasts of attendance) that time-pressed managers can run readily.

Long-term use will depend not only on technology, but also on careful attention to the success factors outlined by Wierenga, Van Bruggen, and Staelin [1999]. These factors helped us to design our implementation and measurement processes. More complex applications will depend even more on critical understanding of the implementation process over time. It is especially important to convince Pathé's top management of SilverScreener's contributions if we are to extend the system to Pathé subsidiaries in other countries.

In movie scheduling, time is of the essence. With such highly perishable products and weekly decisions, managers can maximize profits only if they use current information. In the past, those working together on a project had to be at the same location, but with electronic communication, people and facilities can be widely

dispersed. In this project, we carried out the SilverScreener computer runs nearly halfway around the world from the implementation site. With communication costs virtually zero, and therefore geographic proximity not a requirement, a diverse team of researchers can be assembled to attack a challenging, continuing project. While we expended some effort to establish an efficient information-transmission system, once established it worked very smoothly.

Modern electronic-communication capabilities open new possibilities for marketing-management-support systems: the option of centralized expert centers implementing decentralized applications. The SilverScreener implementation shows that model builders and software do not need to be located near the applications, even for ongoing optimizations. Companies can subscribe to MMSS services from anywhere. Nevertheless, personal contact can be important. We interested Pathé in this project by interacting with some of the team members in previous work.

We are optimistic about the future of MMSSs in the movie industry. It offers challenging problems, and researchers can offer implementable solutions to managers. At Pathé, managers have asked for several extensions of the model, indicating that they see modeling as a help in addressing difficult issues. These extensions concern micromanaging several theaters in the same city, and they include determining optimal daily time slots for different movies, assigning movies to time slots and screens, and managing concessions. In making these decisions, managers must explicitly consider the interdependencies

among the multiple theaters in the city.

Acknowledgments

The authors are listed alphabetically and contributed equally to the paper. We thank the management of Pathé The Netherlands, especially Ilona Van Genderen Stort, for helpful comments. Special thanks are due to Sudhir Saxena and Anoop Sharma for computational help. The many helpful editorial suggestions made by the managing editor, Mary Haight, are highly appreciated.

APPENDIX

We modified the following Silver-Screener algorithm [Swami, Eliashberg, and Weinberg 1999] slightly for scheduling movies at Pathé. Let

- W = length of planning horizon,
- H = number of screens in the multiplex,
- N = total number of movies considered during a planning horizon,
- r_j, d_j = release and due date (if applicable), respectively, of movie j ,
- x_{jiw} = 0–1 variable (1 if movie j is scheduled for i weeks beyond its obligation period starting in week w),
- R_{jiw} = revenue received by the exhibitor if x_{jiw} is equal to 1,
- $GROSS_{jw}$ = box-office gross revenue generated by movie j in week w ,
- POP_{jw} = concession profit generated by movie j in week w ,
- $EXSHARE_{jw}$ = exhibitor’s share of box-office revenue for movie j in week w ,
- OPD_j = obligation period of movie j ,
- C = house nut (a small fixed amount paid every week by the distributor to exhibitor for running expenses),
- $k_j = d_j - r_j - OPD_j + 1$ = maximum possible number of weeks movie j can be shown beyond its obligation period starting in r_j or any feasible week thereafter, and
- $SCR_{ji} = OPD_j + i$ = total screening period for movie j if it is shown for i weeks beyond its obligation period, where $i = 0,$

$\dots, k_j.$

Problem Statement

$$\max \sum_{j=1}^N \sum_{i=0}^{k_j} \sum_{w=r_j}^{d_j - SCR_{ji} + 1} R_{jiw} x_{jiw} \tag{1}$$

subject to

$$\sum_{i=0}^{k_j} \sum_{w=r_j}^{d_j - SCR_{ji} + 1} x_{jiw} \leq 1, \quad j = 1, \dots, N, \tag{2}$$

$$\sum_{j=1}^N \sum_{i=0}^{k_j} \sum_{q_j=w - SCR_{ji} + 1}^w x_{jiq_j} \leq H, \tag{3}$$

$$w = 1, \dots, W,$$

$$r_j \leq q_j \leq d_j - SCR_{ji} + 1, \tag{4}$$

$$j = 1, \dots, N; i = 0, \dots, k_j,$$

$$x_{jiw} \in \{0,1\}. \tag{5}$$

Statement (1) denotes the objective function, which maximizes cumulative revenues over the season. Constraint (2) ensures that a movie is played in only consecutive weeks, if scheduled. The next constraint restricts the total number of movies scheduled in any week to the total number of screens in the multiplex. The set of inequalities denoted by equation (4) is an indexing constraint. (5) defines the decision variable to be binary. We note that Pathé’s exhibitor problem did not involve parameters, such as obligation period, house nut amount C , or due date d_j , but these parameters are retained for the consistency of model explanation.

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