Implementation and Evaluation of SilverScreener: A Marketing Management Support System for Movie Exhibitors

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1. Introduction

The motion picture industry represents an area where marketing management support systems (MMSS) have a high potential for helping managers but an unpredictable chance to succeed. While many of its managerial problems tend to be fairly structured, the decision environment is quite dynamic, contractual arrangements between parties are complex, management turnover appears to be high, and, perhaps, most importantly, the cognitive style of the decision makers is often non-analytical or heuristic (Wierenga, Van Bruggen, and Staelin, 1999). These characteristics represent challenges in developing implementable models for decision makers in this industry. Nevertheless, successful implementation of MMSSs in other areas of the arts and entertainment industry (e.g., Weinberg 1986) provides optimism for the movie industry.

Despite the above-noted challenges, a stream of research that addresses those issues is emerging. Forecasting, for example, has received an increasing amount of attention. Work has been reported on forecasting the enjoyment of movies at the individual level (Eliashberg and Sawhney 1994) and on commercial success of movies at the aggregate level (Dodds and Holbrook, 1988, Sawhney and Eliashberg 1996, Eliashberg and Shugan 1997, Neelamegham and Chintagunta 1999, and Eliashberg, Jonker, Sawhney, and Wierenga 2000). Other topics that have received research and modeling attention include release timing of movies and videos (Krider and Weinberg 1998, Lehmann and Weinberg 1998, 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 is comprised of two key parties: distributor and exhibitor (theater owner). In the U.S., for instance, there are eight major distributors (e.g., studios such as Disney, Universal, Paramount) and more than 250 exhibitors (e.g., Regal, United Artists, AMC) who own jointly more than 30,000 screens. The number of movies shown annually on these screens is roughly 500. In 1999 they generated $7 billion in U.S. box-office revenues from the sales of approximately 1.5 billion tickets. Most of the movies shown in the U.S. are American. Foreign film distributors often do not find

screens available for their films. The situation is somewhat different in Europe. American films are quite popular there. However, they compete more intensively on screens with other domestic and foreign films. Exhibitors in Western European countries such as the U.K., Germany, France, and Holland, are therefore required to select the movies they show from larger consideration sets that include local, American, and other foreign films.

A theater owner with an objective of effective screen management thus faces a complex scenario. The complexity comes from various sources. First, the relatively large number of movies available ("Too many pix, too few screens," trumpets a *Variety* 1995 headline) combined with a short and decaying audience appeal over time poses a complex management challenge. The decision is further complicated because it is made for a number of screens in a multiple screen theater (i.e., a multiplex). Second, each week's release of new movies brings continual pressure from the distributors to generate screens and playtime for them. Third, exhibitors often possess a number of facilities (i.e., theaters) in the same geographical area. This presents another booking challenge – managing the interdependency among several facilities. Fourth, the nature of the distributor-exhibitor contract in the motion picture industry in the U.S. as well as in Europe is quite unique. For example, in the U.S.A., 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 also 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 of the movie playing, but shifts to the exhibitor's favor later on. Distributors thus have a strong incentive to promote the movie intensively in their initial play period. On the other hand, the longer 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 just described indicates that there is a real need for a MMSS that can help theater programming managers in their task of optimally choosing movies for their limited screen capacity. In fact a system with that goal, is available. Swami, Eliashberg and Weinberg [SEW](1999) have developed the

SilverScreener model. SilverScreener helps to select and schedule movies for a multiple-screens theater over a fixed planning horizon in such a way that the exhibitor's cumulative profit is maximized. In an example, they showed in an ex-post analysis that if a particular theater in New York City would have used SilverScreener, this theater could have realized an estimated profit increase of 38%. However having a decision support system available is one thing, but having it actually 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 analysis, such as the movie scene.

In this paper we describe how SilverScreener was implemented and used by a movie theater company in the Netherlands. We will first describe the decision situation and our implementation strategy. After that we present the SilverScreener model and a number of issues related to the specific implementation. In this case the model was used in an adaptive scheduling mode, which requires frequent interaction between the users of the model and the model operators. Given that model users and model operators/builders are located on different continents, this implies a heavy dependence on modern Internet Communication Technologies (ICT). Subsequently we will analyze the results of using SilverScreener for the company, both in terms of the effect on sales/profits and on the satisfaction of the managers involved. Finally we will formulate conclusions and lessons learned.

2. Implementation Strategy

Our implementation strategy for SilverScreener was guided by Wierenga, Van Bruggen and Staelin's [WVS] (1999) framework, which relates the success of a marketing management support system (MMSS) 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).

[Figure 1 About Here]

The *demand side* of the MMSS is movie programming at Pathe The Netherlands. This movie exhibitor, headquartered in Amsterdam, asked us to carry out an implementation of SilverScreener for one of their theaters. Pathe, the largest movie theater company in the Netherlands, owns a large chain of cinemas. In the Western part of the country (the Randstad), Pathe is the dominant exhibitor. The Programming Department of Pathe chooses which movies to play in which theater(s) and on which screen, in a given week,. Programming decisions are made centrally in Amsterdam, for all the Pathe theaters in the country. The Programming 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 that are available, and so on. Programming decisions are made on a week-by-week basis. In the Netherlands a new movie week, starts every Thursday. Every Monday morning a team of three people meets and jointly prepares a movie allocation schedule for all the Pathe screens in the country for the following movie week, effective the next Thursday. It was decided to choose 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 is one of the three theaters Pathe owns in The Hague. Buitenhof was renovated about two years earlier and Pathe management wanted to give it a further boost by optimizing the movie programming for this theater.

Using WVS's framework, the following implementation strategy for SilverScreener MMSS was determined:

1. An environment was chosen with a relatively favorable initial attitude towards a marketing management support system.

2. An excellent technical match was made between the decision problem and the marketing management support system.

3. Given the low experience with models (and analytical methods in general) in the organizational environment, the MMSS was operated externally.

4. The SilverScreener's recommendations were accessible instantly through the Internet to the decision makers, and presented in a very user-friendly way.
5. Constant involvement of the users was maintained during the process.

We will elaborate these items in the following.

(1) As Figure 1 indicates the attitude towards the MMSS (in this case SilverScreener) among the users is an important determinant of its success. In this context we thought it would be a good idea to have Pathe The Netherlands as our client for SilverScreener. Two of the three members of the Pathe programming team had participated earlier in the successful implementation of another MMSS, the Moviemod model (Eliashberg, Jonker, Sawhney and Wierenga 2000). Moviemod is also a decision support system, aiming at forecasting the "number of visitors" (attendance) of a new movie. This earlier experience helped to form a relatively favorable initial attitude towards MMSSs in general, and SilverScreener in particular. This attitude towards the system is an important factor, because on another relevant characteristic of the decision makers, cognitive style, the situation was mixed. One of the members of the Pathe programming team made it very clear that he had no trust whatsoever in mathematical models. Nevertheless that same person had a very good intuitive "feel" for which movies will be successful and which will not. In terms of cognitive style, the other members of the team are more analytical and "in-between," respectively. The development of the attitudes of the SilverScreener users over time was monitored, by administering an attitude scale three times during the SilverScreener implementation period (see below).

(2) Movie programming decisions represent a relatively structured type of problem. Moreover the movie industry is very rich on data. This situation creates a demand for an optimizing model. This is exactly what we have on the *supply side*. As we will see later in more detail, SilverScreener models the movie programming problem in terms of (decision) variables and relationships, and is able to find the optimal solution. So,

on this count, there is a good match. This technical match is a favorable condition for, but not a guarantee of success, however.

(3) The (analytical) SilverScreener approach is new to the organizational environment of Pathe and the team of decision makers has a mixed composition as far as cognitive style is concerned. Given an overall lack of experience with analytical methods in the company, it was decided that the Pathe decision makers would not operate SilverScreener themselves. Too many technical barriers would prevent successful use. Therefore the model developers carried out the weekly SilverScreener runs and made recommendations to Pathe's programming team. We felt that this way of operating has the best fit with the demand side.

(4) The demand side factor *time constraints* is very important to movie scheduling at Pathe. Every week new information from the market (ticket sales, movie releases) comes in, and the new recommended schedule has to be on the desk of the programming team before the weekly programming session starts. Therefore we relied heavily on the communication possibilities offered by the Internet. The remote running of a model is possible since input and output data for SilverScreener can be transferred globally, instantly and without any costs**.** Thus, in terms of *design* of the MMSS we made the results immediately *accessible* to the users, *presented* as directly implementable recommendations. In addition, one of the authors was located in Holland, which facilitated personal interaction.

(5) As Figure 1 indicates, *user involvement* is an important element of the *implementation process* of an MMSS. Throughout the process the users of SilverScreener were directly involved. There was a frequent (on-line) interaction between model users and model builders/operators. As indicated in Figure 1, another implementation factor that can stimulate the success of an MMSS a great deal, is the presence of an "*MMSS champion*". In this case we had such a champion available. One of the members of the programming team was a great believer in the value of SilverScreener for Pathe. She put a lot of effort into obtaining the data needed for

running the model and also in bringing the SilverScreener results to the attention of the other team members, every Monday morning.

3. Modeling Framework

We formulated the exhibitor's problem as an integer programming model, which is a special case of the SilverScreener model (SEW). In this paper, we briefly summarize the general structure, but we elaborate on the specifics of the Pathe implementation The interested reader can find a full mathematical formulation of the model in SEW (1999). For each movie that is available to Pathe, the manager has to decide whether to schedule that movie and, if so, for how many weeks.[1] Using the rolling horizon approach in SEW, each week Pathe management selects the movies (six in the case of Buitenhof) that will optimize its results over the next 8 weeks. However, they implement the recommendation provided by the model for the first week. In the following week, with a revised data set, the model is rerun with an eight week horizon, now set one week ahead. This approach allows Pathe to consider the long run implications of its choices, while still allowing for the decisions to be based on the most recent data (about ticket sales, movie availability, and contract terms).

3.1 The SilverScreener Model

The objective function of the integer programming model to maximize revenue over W weeks in a multiplex is as follows:

$$\max \sum_{j=1}^{N} \sum_{i=1}^{d_j - r_j + 1} \sum_{w=r_j}^{d_j - i + 1} R_{jiw} x_{jiw} \qquad (1)$$

where

x_{jiw} - binary (decision) 0-1 variable which takes value 1 if movie j is scheduled for i weeks starting in week w,

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[1] Computational efficiency is obtained by defining a binary variable [$x_{jiw} \; e \; \{0,1\}$] which takes on the value 1 if movie j is scheduled for i weeks starting in week w, see below.

R_{jiw} - total revenue (explained in the next section) received by the exhibitor if x_{jiw} is equal to 1,

W - length of planning horizon,

N - total number of movies considered during the planning horizon,

r_j - release date of movie j,

d_j - last week that movie j can play.

In addition, there are a number of mathematical constraints on the model to ensure that, for example, no movie is scheduled before it is actually available and all screens are fully booked. We coded the above model in AMPL (Fourer, Gay, and Kernighan 1993), a modeling language for mathematical programming.[2]

3.2 Screen Allotment Heuristic

Each week, SilverScreener recommends a set of movies irrespective of the screen on which the movie plays. Since the six screens at the Buitenhof theater have different seating capacities (see Table 1), we assign movies to screens according to the following simple heuristic: Each week, allocate the movie with highest 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. In other words, the application of the model first chooses a set of movies, and then the movies are allocated to the theater screens in the order of their capacities. The screen allocation heuristic is in accordance with the managerial decision making in this context. Sellouts of movies in the smaller screening rooms are unusual.

[Insert Table 1 About Here]

[2] The analysis is conducted on an Intel Pentium class computer, thus resulting in user-friendly implementation. The time taken to solve such problems was of the order of a few seconds.

3.3 Exhibitor's Profit Contribution

The profit contribution, R_{jiw}, generated by Movie j if it plays for i weeks starting in Week w, is sum of two components – (a) concession profits (e.g., popcorn and soft drinks sales) and (b) exhibitor's share of the movie's box-office gross revenue. Exhibitor's share is the percentage of the box office revenue received after paying the distributor's share (rental cost) and tax deductions. The exhibitor's share is not fixed, but varies from movie to movie and is generally higher the longer the movie plays at the theater.

Accordingly, R_{jiw} is given by the following expression.

$$R_{jiw} = \sum_{u=w}^{w+i-1} POP_{ju} + EXSHARE_{ju} * GROSS_{ju}, \qquad (2)$$

$$j = 1, \cdots, N, \quad i = 1, \cdots, d_j - r_j + 1, \quad w = r_j, \cdots, d_j - i + 1.$$

where

POP_{ju} – concession profits (e.g., popcorn and soft drinks sales) generated by Movie j in Week u,

$GROSS_{ju}$ – box-office gross revenue generated by Movie j in Week u,

$EXSHARE_{ju}$ – 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 respective distributor-exhibitor pairs. Both POP_{ju} and $GROSS_{ju}$ are directly proportional to the corresponding number of visitors to the theater.[3] The number of visitors is determined by the demand function, which is explained below.

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[3] Specific approaches to estimating the variables *EXSHARE*, *POP*, and *GROSS* in the context of the Pathe implementation are discussed below.

3.4 Demand Model

Consistent with empirical results reported in Swami, Eliashberg and Weinberg (1999), Jedidi, Krider, and Weinberg (1998), Krider and Weinberg (1998), and Sawhney and Eliashberg (1996), we use 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 incorporate a separate (dummy) variable to account for the effects of holidays. Accordingly, we model demand as the following three-parameter exponentially declining function.

$$\text{Demand (number of visitors)} = VISITOR_{ju} = a_j e^{b_j u + cH + e} \qquad (3)$$

where $a_j > 0$ and $b_j < 0$ are opening and decay factors for Movie j,

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

c is the holiday factor[4], and $\varepsilon \sim \text{normal}(0, \sigma^2)$.

4. Case Study: Implementation of SilverScreener at Pathe, The Netherlands

SilverScreener was implemented at the six screen Buitenhof theater in The Hague (see Table 1). After some preliminary work starting in the early fall of 1999, the model was first implemented on a weekly basis using the rolling horizon approach starting in week 45 (calendarwise) of that year. In the last two weeks of 1999, the manager primarily

[4] If there is more than one holiday in a season, then the proposed model could become a vector having holiday-specific elements such as H_1, H_2, H_3, and so on.

responsible for SilverScreener went on holidays 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 then monitored the model's performance for the first 8 weeks of 2000. Usage of the SilverScreener model continues as of this writing (May 2000). We report the process and results for 1999 in some detail, and summarize the year 2000 experience more concisely.

4.1.1 The Availability of Data and Other Managerial Estimates

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

- **Future Releases** – This contains a list of all the movies (with release dates) that were to be released in the second half of the Year 1999. The manager also indicated the movies considered specifically for Buitenhof. The consideration set as described below.
- **Movie Type –** This conveys the genre to which the movie belongs, that is, whether the movie is Drama, Fiction, Comedy or Action type.
- **Expected Visitors** - Management provided inputs from which estimates regarding the expected demand of each new movie in the consideration set were derived using the "case-based" reasoning approach. Case-based reasoning is based on the principle that a new problem is solved, by finding an earlier problem (analogy) in a case base with similar characteristics. The solution for the similar case is then used, after possible adaptation, for the new case (Kolodner 1993; Leake 1996). For a new movie this means that in an historical data base a "matching movie" is sought in terms of genre and other characteristics. The expected number of visitors and the decay pattern for the new movie is taken from the matching movie in the case base.
- **Weekly Performance Data (for Week 27-39)** – As illustrated in Table 2, data on all the movies that had actually played at Buitenhof prior to Week 39, the first week of implementation plan development, were provided. The information includes the Week of the year, Screen Number, Movie Title, Actual Number of Visitors, Total

Box-Office Receipts, Net Receipts After Taxes[5], Film Rental to the Distributor (based on the sharing percentages specified in the contract).

[Insert Table 2 About Here]

The consideration set of movies consists of the movies already released and the movies expected to be released during the implementation horizon. Thus, at Week 40, for instance, it included the movies released between Weeks 27 and 39, and the movies slated for release between Weeks 40 and 52**.** The consideration set of movies is therefore *dynamic* and *flexible*. For example, in a particular week, the distributor may decide to postpone a movie that was to be released that week. Alternatively, some movies become available ahead of their scheduled release date. Moreover, a new movie may unexpectedly become available in a particular week. This happens more often with foreign releases. Two movies (DEEP BLUE SEA and BLUE STREAK) that were screened at Buitenhof became available in late 1999. The complete consideration set of movies in the course of this study from Week 40 until Week 52 is shown in Table 3.

[Insert Table 3 About Here]

4.1.3 Sequencing of Information Flows and Decisions

The timing of events is of immense importance in the adaptive scheduling application. It indicates when and how data become available to the modeler, how long it takes to prepare and communicate recommendations, when the decisions are taken and when and how the "feedback" is sent back to the modelers.

This sequence highlights an important and (possibly) unique feature of this implementation project. The coordination of the implementation involved activities spanning three continents – North America, Asia and Europe. The research collaborators on this project are based in the U.S., India, Canada, and The Netherlands. While the

[5] The taxes are approximately 10% of total box-office receipts.

empirical analysis, execution of the model and the final recommendations were conducted each week at the Indian Institute of Technology, Kanpur, India, the implementation site is in The Netherlands. At the same time, the frequent discussions were occurring among the researchers via e-mail across the three continents. Therefore, proper coordination of activities in this project required continual use of the information and Internet-based technologies.

Since at Pathe, a new movie starts its run on Thursday of a calendar week, we define a *Movie Week* as the period from Thursday of a calendar week to the Wednesday of the next calendar week. Thus, the actual replacement of a movie occurs at the beginning of a Movie Week (i.e., Thursday). The replacement decisions for the upcoming Movie Week (t+1) are taken on the Monday morning of the running Movie Week (t). Pathe collects the performance data[6] of the previous week (t-1) on Thursday of the current Movie Week, and it is sent on Friday for analysis. The actual schedule of the movies playing in the current week (t) was also sent with this data. At that moment the results for the current week are not known yet, of course. An illustrative case of this data transmission and information sharing scheme is presented in the timing of events diagram shown in Figure 2. An enhanced ICT system should be able to use the most recent data.

[Insert Figure 2 About Here]

Figure 2 shows the occurrence of different events in a Movie Week for Movie Weeks 45, 46, and 47 in 1999. As shown in the figure, Pathe implements a new movie schedule at the beginning of a Movie Week (e.g., Thursday of Week 45 = t). On Friday, Pathe 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 Indian Institute of Technology. The data is then analyzed for model implementation, scheduling recommendations are developed and communicated so as to reach Pathe managers before they make "Monday morning" replacement decisions for Movie Week 46. The process repeats itself the next week. It is clear that every week, only a period of two days over

[6] The performance data sent every week is of the similar format as shown in Table 2.

the weekend is available for data analysis and developing recommendations. Therefore, the availability of data (in particular the most recent box-office receipts) on time is critical in such applications. We discuss the importance of web-based technologies in this context in the conclusion section.

4.1.3 Parameter Estimates for the Buitenhof Theater

We now discuss the estimation of the model parameters based on the managerial inputs.

Exhibitor's Profit Contribution:

To estimate R_{jiw}, total profit contribution 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 $EXSHARE_{jw}$ (see Equation 2), calculated appropriately over i weeks. Starting with the number of visitors for movie j in week w, $VISITOR_{jw}$, the corresponding revenue, $\boldsymbol{GROSS_{jw}}$, the movie generates for Pathe is estimated as follows.

$$GROSS_{jw} = \text{ATP} * VISITOR_{jw} * \text{Tax Deduction Factor} \qquad (4)$$

where ATP is average ticket price at Pathe and is estimated to be Dfl 13.5 (Dutch currency) and tax deduction factor is 0.89725.

The corresponding profit contribution from concessions, $\boldsymbol{POP_{jw}}$, is estimated as follows.

$$POP_{jw} = \text{Average Concession Profit Contribution Per Visitor} * VISITOR_{jw} \qquad (5)$$

The average concession profit per visitor at Pathe is estimated to be Dfl 2.00.

The estimation scheme for the contract terms, $\boldsymbol{EXSHARE_{jw}}$, is done as follows. The scheme varies depending on whether a movie has already played at the theater or is going to be released in the future.

- **For the movies that have already played for some weeks**, we generally find that by the end of the contract stream, the distributor's share tends to stabilize at 27.5%. Accordingly, the heuristic employed was: if the contract term for the actual run ends at 27.5%, stabilize it at 27.5% for the coming weeks, otherwise, use the contract terms of the "matching movie" from the previous year's data.
- **For future releases,** we classify movies as Type A, B or C, depending on the expected number of visitors. For example, if the weekly number of visitors is expected to exceed 1000, it is treated as Type A movie. This scheme is used at Pathe and the general idea behind this classification is that the distributor bargains for better terms for Type A and B movies in the early part of a movie's run. The contract terms associated with the three different types of movies are shown below.

Contract Term Scheme (% Distributor's share)

	A	B	C
First Week	60	50	40
Second Week	50	40	40
Third Week	40	30	40

From Week 4 onwards, the distributor's share declines by 2.5% per week until it stabilizes at 27.5%.

Demand Estimation and Holiday Factors:

Demand Estimation for New Movies

According to Equation (3), estimation of $VISITOR_{jw}$, the demand for movie j in week w, involves estimates of the opening and decay parameters, a_j and b_j, respectively, and the holiday factor, c. During the implementation period of SilverScreener (Week 40 to 52), there were only three holiday weeks: Week 42 (****), Week 43 (****), and Week 52 (Christmas Holiday). Therefore, we estimate the opening and decay rates of a movie by

transforming the three-parameter model of (3) into a two-parameter exponentially declining model, which involves only opening and decay rates. Then, the revenues of the movies in the above mentioned holiday weeks are multiplied by their respective holiday factors. These holiday factors are estimated independently and explained later in this section.

As mentioned earlier in the context of adaptive (rolling horizon) scheduling, during a given Movie Week, some of the movies in the consideration set have already been released, while some are scheduled for release. Accordingly, we divide the demand estimation scheme (involving opening and decay parameters) for forecasting future demand into two parts:

(a) For movies already released, we use the two-parameter exponentially declining model by log-transforming (3) and fitting a regression model. Clearly this approach requires actual data for at least two weeks. For the movies where the data are available for only one week, we use the first week's actual sales and use the managerial estimates for the later weeks. Regression-based estimates are generated to forecast attendance for the later weeks.

(b) For forthcoming movies, the following scheme is adopted:

i. If the manager's estimates follow a consistently decreasing pattern during the first three weeks for which they are provided, then we use the regression model version of Equation (3) using the three data points to forecast demand from Week 4 onwards.

ii. If the manager's estimates do not decrease consistently then we use the estimates for the first 3 weeks. To forecast demand from Week 4 onwards, we use the decay factor of the "matching movie" from the previous year's (1998) data (the opening rate in this case is based on the last managerial estimate).

iii. If a "matching movie" is not given, then we follow a procedure similar to (ii) except that the decay factor used in this case is the average of decay factors of all the movies in the previous year's data.

Demand Estimation for Re-Runs

Most movies are played in a continuous length of time. However, occasionally some movies[7] may play for several weeks and then resume (i.e., re-run) after a break of a few weeks. The demand estimation scheme followed in such cases increases the counter for the week number in Equation (2) even during the intermittent weeks in which the movie is not shown.

Estimation of Holiday Effects

Weeks 42, 43, and 52 are holiday weeks during the 1999 implementation period. Therefore, we need to estimate c_{42}, c_{43}, and c_{52}, holiday factors for the Weeks 42, 43, and 52, respectively. At the beginning of the project, Pathe provided us with data for the same theater for the first 26 weeks of 1998. There were five holidays in the first half of 1998: Week 8 (spring vacation), Week 15 (Easter), Week 18 (Queen's Birthday), Week 21 (Ascension Day), and Week 22 (Pentecost). The values of the corresponding holiday factors based on 1998 data are as follows: $c_8 = 1.47$, $c_{15} = 1.82$, $c_{18} = 1.92$, $c_{21} = 2.37$, and $c_{22} = 1.42$.

The manager estimated that both c_{42} and c_{43} in 1999 are likely to have a similar effect as that of c_8 and that c_{52} in 1999 is likely to be similar to c_{21}. This was done to "de-holidaze" the data for estimation purposes. Accordingly, the demand estimates given by two-parameter exponential model (considering opening and decay rates) were multiplied by 1.47 for Weeks 42 and 43, and by 2.37 for Week 52 of Year 1999.

4.2.1 Implementation Results

Table 4 presents the actual schedule used by management in Weeks 40 to 52. Starting in Week 43, the Buitenhof theater had weekly SilverScreener recommendations available, so the actual schedule from that point onwards reflects management's response to these

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[7] In the current data set, the movies *The Mummy* and *Analyze This* are examples of re-runs. *The Mummy* was first played from Week 27 to 36 and then played again in Weeks 40 and 41. *Analyze This* first played from Week 33 to 39 and then in Weeks 43 and 44.

recommendations. Table 5 presents each week's recommendation following SilverScreeren approach.[8]

The face validity of our recommended schedules is very high. Typically, at least 5 of the 6 weekly recommended movies match the actual schedule. Differences are sometimes due to last minute changes in availability. In Week 45, for example, the only difference is that the movie DBS was in the actual schedule whereas BD was in the recommended schedule. However, this is due to the entry of DBS in the consideration set at the last moment. The manager probably decided to play it in the Buitenhof after seeing its success at another theater. Of course, by the next week DBS had entered the consideration set and its continuation was recommended.

[Insert Tables 4 and 5 About Here]

4.2.2 Contingency Schedules

A specific element that Pathe takes into account, but which was not an element of SilverScreener, is the possible implication that a movie choice for Buitenhof may have for Pathe's other two theaters in The Hague: Metropole and Scheveningen. For example, sometimes only a limited number of copies of a particular movie are available. If a copy is used for Buitenhof, there may not be one left for Metropole. At other times, the decision is driven by more strategic considerations. Despite SilverScreener's recommendation, the manager decided not to play the movie *Mickey Blue Eyes (*MBE) 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 Pathe. This option determines the best schedule if the first, second and third best movies are removed from consideration at the Buitenhof. These options,

[8] No recommendations could be made in Week 44 because of data communication problems.

which took only seconds to run on a computer, were considered to be extremely helpful by management.

5. The Success of the SilverScreener Implementation

The success of a marketing management support system can be assessed by multiple criteria (see Figure 1). First we have *technical validity.* Based on Swami, Eliashberg and Weinberg (1999), and numerous test runs, we are confident that SilverScreener optimization approach accomplishes its goals in a timely and efficient manner. So technical validity is not an issue here. The second criterion of implementation success is whether or not an MMSS is *adopted* and *used* by the decision maker. In the case of Pathe SilverScreener was used every week. One time, because of a transmission problem, the recommendations came late and the people at Pathe became somewhat uneasy about this, because they wanted to see the recommendation.[9] So on this count SilverScreener is a success too. The next two levels where the success of an MMSS can be measured are *impact for the user* (satisfaction, perceived usefulness, etc.) and *impact for the organization* (sales, profits, etc.). We start with the level of success mentioned last: the impact of SilverScreener on sales and profits.

5.1 Impact of SilverScreener on Sales and Profits

Profitability Analysis:

The objective of SilverScreener is to maximize the exhibitor's cumulative profit contribution over the planning horizon. In 1999, the implementation period for the theater Buitenhof encompasses the last 10 weeks of the year, that is, Week 43 to Week 52. We also have data for the first 8 weeks of 2000.

We followed the adaptive decision making approach for the 10 time windows in 1999. In order to see how well Buitenhof The Hague has done, given SilverScreener's recommendations, we compared its results with two other Pathe theaters with a somewhat

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[9] Although the recommendation could not arrive in time, the last week's recommendation was still useful, since it included suggested schedules several weeks ahead.

comparable positioning, in terms of movies and audience. For this purpose Pathe-Rotterdam and Pathe-Groningen were chosen. For these theaters we have also the data on weekly tickets sales for 1999 and 2000. Only the programming of Buitenhof The Hague was supported by means of SilverScreener in late 1999 and early 2000.

The profitability analysis of the model is done on a weekly basis. The analysis is done in terms of the number of visitors (attendance) at each theater. Preliminary analysis indicated that the outcomes on the basis of profitability did not produce any significant difference in the comparative results; the profit data are obviously confidential.

While we started actively interacting with Pathe in Week 40, and actually proposed a schedule for Week 43 (but not for Week 44 due to start-up difficulties), our regular ongoing communication of scheduling began in Week 45. At this point in time, management actively reviewed the SilverScreener recommendations. In Weeks 51 and 52, several members of the management team were away on Christmas holiday and the schedule for Weeks 51 and 52 was set to be basically the same as that of Week 50. No SilverScreener runs were made for weeks 51 and 52 of 1999, and also not for the weeks 1 to 3 of 2000. Weekly SilverScreener runs commenced again in Week 3 of 2000.

Table 6 shows the weekly comparison of the three theaters for the 1999 effective implementation period from Week 45 to 52. The figures in the table show the percentage change in the number of visitors from 1998 to 1999. As this is not a controlled experiment, interpretations of causality are suggestive at best. Nevertheless, for the Rotterdam and Groningen theaters this change may be attributed to the periodic change from one year to other but for Buitenhof it may be due to periodic change as well as effect of model implementation. The change in attendance at the Buitenhof are much higher then for the other two theaters for Weeks 45-50, though the performance of the two other theaters improved in the last two weeks of the year.

[Insert Table 6 About Here]

Management's review of SilverScreener at the start of 2000 was favorable and they wanted to continue using the model. While some communication problems interfered with the gathering of data and reporting of recommendations at the start of the

year, by Week 3 of 2000, the multi-continent SilverScreener implementation was fully operational again.

For the first 8 weeks of the year, we continued to gather comparative data for the three Pathe movie theaters. As shown in Table 7, we ranked the three theaters by percentage change in attendance for each of the 16 weeks in our sample. Consistent with the earlier results, the Buitenhof theater ranked first for 9 and second for 4 of the 16-weeks period studied.

[Insert Table 7 About Here]

For the first 42 weeks of 1999, the cumulative attendance at the Buitenhof decreased by 6.1%. For the last 10 weeks of the year, cumulative attendance increased by 10.3% as compared to the previous year. This improvement, while most likely be driven by other factors in addition to SilverScreener implementation, may have been influential on management's acceptance of the SilverScreener system.

5.2 Managerial Perceptions of the Effect of SilverScreener

Here the issue is whether or not the Pathe management perceives SilverScreener as useful and an effective tool. We have different pieces of evidence that the answer is yes.

Attitude Scale

First, as was already mentioned, we measured the attitude towards the SilverScreener among the members of the Pathe Programming Team. For this purpose we used three items from a scale developed by Schultz and Slevin (1975) for measuring the attitude towards an information system. We administered the scale three times: before the team actually had used the SilverScreener recommendations (week 42), after the effective implementation period, referred to earlier (week 49) and after a change in management, early in the next year (week 13). The results are given in Table 8.

[Insert Table 8 About Here]

Table 8 shows that for all the managers involved, the attitudes towards SilverScreener (which started at a not too unfavorable level) generally became more favorable over time. It is interesting to note that the manager who was the most skeptical towards the MMSS to begin with (Manager 3) apparently needed the longest time to change his attitude, but finally reaches the same score as the MMSS champion (Manager 1). Interestingly, the champion, even more so than Manager 2, questioned whether SilverScreener would make her decisions easier. It is also interesting that the new (senior) manager, replacing Manager 2, who retired in early 2000, started with a relatively favorable attitude. This may be due to the positive way people in the company talked about the system. As Figure 1 shows, communication is a critical success factor of an MMSS.

These results demonstrate that after (extended) use the managers apparently have an increasingly positive perception of SilverScreener's contribution. However they are realistic enough not to follow SilverScreener's recommendations blindly. There can always be considerations that overrule SilverScreener's advice. Asked to give an (subjective) estimate of the influence of SilverScreener's recommendations on the ultimate decision, Manager 1 mentioned a percentage of 70%.

New Manager and New Theater

As discussed, the new senior manager has a relatively positive attitude towards the SilverScreener system. Her behavior is consistent with this attitude. After succeeding her predecessor as the new boss, she has urged the SilverScreener team to continue with making the recommendations

Pathe has recently opened a new, very large theater with fourteen screens, near the new soccer stadium Arena in Amsterdam. The SilverScreener team has been asked to take on the programming for this theater.

Overall, these indicators of management's perceptions demonstrate that SilverScreener has also been successful as far as the satisfaction of the theater management is concerned.

6. Summary and Conclusions

The Silver Screener model has been both adapted and adopted with successful results. Starting in October 1999 and continuing through the first few months of 2000 (when this analysis was prepared), the system has been in continuous use. While an explicit experiment to measure the impact of SilverScreener on performance was not possible in this managerial setting, the comparative results indicate that financial performance was improved in the Buitenhof , the theater where the model was implemented.

The regular use of SilverScreener by Pathe management demonstrates that the potential for improvement in managerial decision can be realized. However, as indicated at the start of this paper, there are a number of hurdles to be overcome in doing so. These represent both managerial and technical challenges.

For a successful implementation, the published version of SilverScreener had to be adapted to the needs of Pathe management. This is to be expected. Fortunately, the SilverScreener system proved to be flexible enough to provide a basis for needed changes while still retaining its "promised" ability to yield improved outcomes. The model can be adapted in at least three ways. First, by changing the actual mathematics of the model itself. While only minor changes were made in the mathematical programming part of the model, a new demand estimation system was developed for Pathe. Second, heuristic approaches can be developed to supplement the core model. This was done in several places. For example, since management had to consider the possibility of assigning some movies to other theaters, we developed a set of contingency schedules so that management could see the impact of removing a movie from the consideration set and have available a new set of recommended movies. While this served the present situation well, in the long run more formal treatments of the multi-theater case will likely be required if the system is to be adopted across the Pathe chain of theaters. Third, managers may do a post-hoc re-assessment of the SilverScreener recommendations. As discussed, mangement followed some, but not all, of the SilverScreener recommendations. While the exact cause of these changes was not tracked, in another setting (Weinberg 1986), the manager occasionally revised regression based forecasts of attendance at performing arts events.

Continued success and use of the MMSS at Pathe will require transfer of the operation of SilverScreener to Pathe management. One reason for the authors conducting this study was to learn what was required for a successful implementation. A next step is to develop a user friendly version (including automatic entering of box office results and developing of attendance forecasts) that can be readily run by time pressed managers whose cognitive styles are not necessarily analytical.

Long-term usage, however, will depend not only on technology, but also on careful attention to the success factors as outlined in Wierenga, Van Bruggen and Staelin [WVS] (1999). In this paper, we showed how these factors helped in the design of our implementation and measurement process. More complex applications will depend even more on critical understanding of the implementation process over time. Especially, it is important to convince the top management of Pathe (top management support is an important implementation factor for MMSS in Figure 1) of the contribution of SilverScreener. This may make it possible to roll out the system to Pathe subsidiaries in other countries.

Web Based Communications

In movie's scheduling, time is of the essence. With such highly perishable products and weekly decisions, profit maximization can only take place if the most updated information is used. However, while historically this required those involved in a project to be located at the same geographic location, electronic communication now makes it possible for people and facilities to be widely dispersed. In this project, the SilverScreener computer runs were literally carried out nearly half way 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, but continuing (as compared to a one-shot) project. While some effort was required to establish an efficient information transmission system, once established it can work extremely smoothly.

We think that the ICT facilities, which are available today, open new possibilities for marketing management support systems: the option of centralized expert centers with decentralized applications. As the SilverScreener implementation has shown, it is not

necessary to have highly qualified model builders or even high level software at the physical location of the application. Even ongoing optimization can take place from a very distant place. A company does not necessarily have to own or operate an MMSS itself, but may subscribe to an MMSS service from a place elsewhere in the world. This brings very sophisticated MMSS within the reach of (small) companies who do not have the resources to aquire the expertise and the software themselves. Nevertheless, the role of personal contact should not be underestimated. Initial interest in this project was generated through interactions with some of the team members in previous work.

Concluding Comments

We are optimistic about the future of MMSS in the movie industry. Our experience at Pathe, combined with a number of interesting research streams as illustrated at the start of this paper, suggest that there are both challenging problems and implementable solutions available to managers in the movie industry. More directly at Pathe, the fact that management has asked for several extensions of the model indicates that modeling is now seen as a way to help address difficult issues.

We are also optimistic about the effect of the current ICT possibilities on the further adoption and use of MMSS. They will enable the global rollout of new tools and systems in a very short period of time.

Nevertheless we should always combine this with sufficient attention to the specifics of the implementation in the actual company. As marketing management instructors in four different countries, we often urge executives to "Think global, act local." We believe that is good advice for management scientists as well.

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Table 1: Screen Capacity

SCREEN	1	2	3	4	5	6
CAPACITY	434	342	216	151	139	113

Table 2: Weekly Performance Data Produced at Buitenhof

Week	Screen Number	Title	Number of Visitors	Total Box-Office Receipts	Net Receipts After Taxes	Film Rental to Distributor
9942	1	Star Wars Episode1	4878	65247.5	61648.83	30824.4
	2	The Haunting	3555	48528	45781.32	22890.7
	3	The Runaway Bride	1245	17196	16222.71	6489.08
	4	Austin Powers 2/spy	459	6136	5788.7	1736.61
	5	Big Daddy	1647	21081	19888.28	7955.32
	6	Tea With Mussolini	339	4708	4441.53	1776.61

Table 3: Consideration Set of Movies

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 CROWS 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	SQUAD THE (SQUAD)	34	BLUE STREAK (BS)

Table 4: Actual Schedule for Weeks 40-52

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	JDT

Table 5: SilverScreener Recommended Schedule (Based on Adaptive Scheduling)

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

* - The recommendation could not be made for Week 44 due to data communication problems.

Table 6: Weekly Percentage Change in the Visitors from 1998 to 1999

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 7: Weekly Ranking of Theaters Based on Year-to-Year Change in Total Number of Visitors

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 8: Measures of Managers'Attitude towards SilverScreener over Time

	Manager 1			***Manager 2***		***Manager 3***			***New***
	Wk 42[a]	Wk 49[a]	Wk 13[b]	Wk 42	Wk 49	Wk 42	Wk 49	Wk 13	Wk 13
Item 1 I think that movie planning decisions will be easier when using SilverScreener	2[c]	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

[a] 1999 [b] 2000

[c] Scale (1 = strongly disagree, 5 = strongly agree)

Figure 1: Integrative Framework of the Factors that Determine the Success of a Marketing Management Support System

(Wierenga, Van Bruggen, and Staelin 1999)

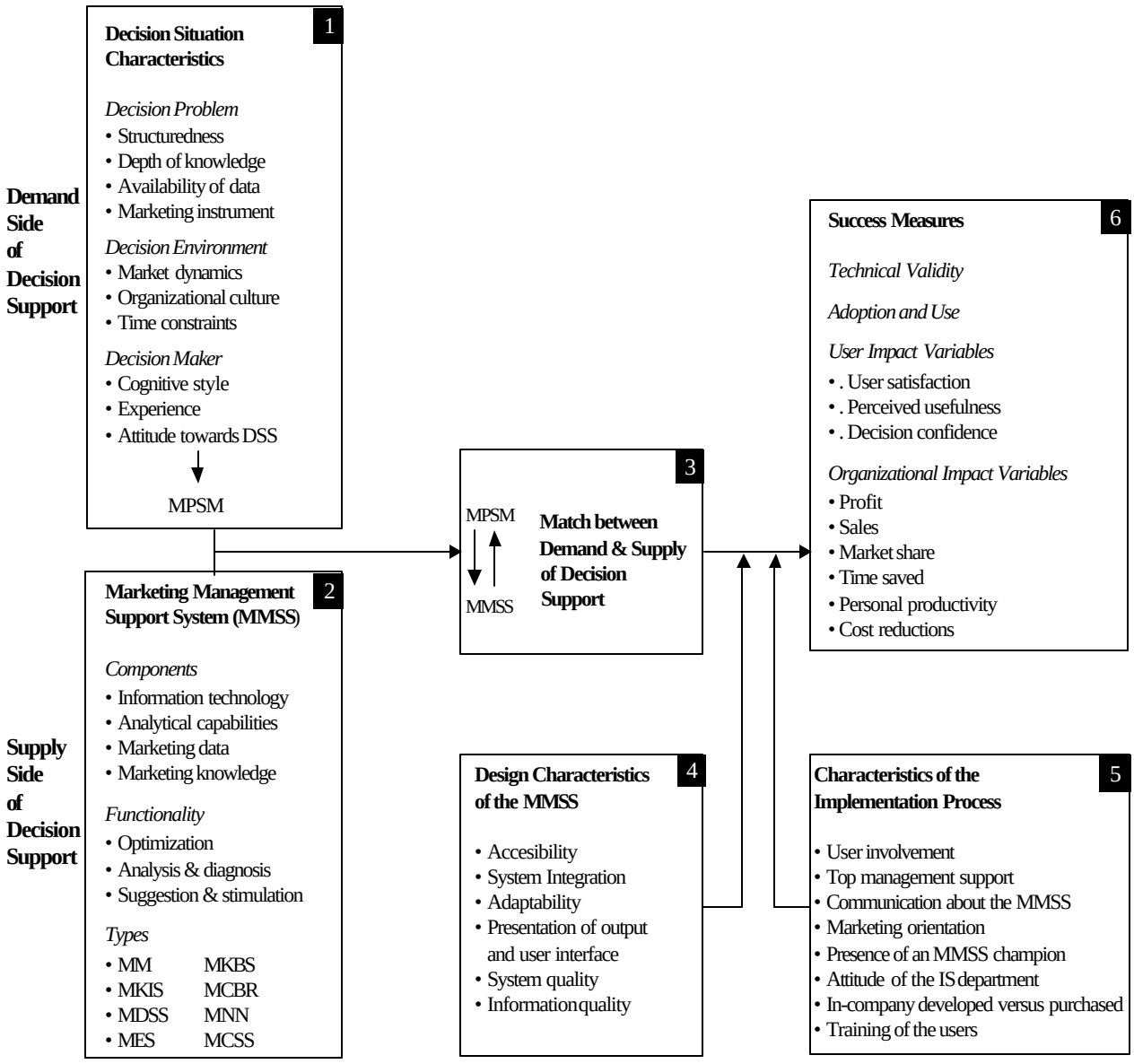

Figure 2: Timing-of-Events Diagram for *SilverScreener* Implementation Project at Pathe Theaters