Strategic Resource Management under Causal Ambiguity – An Empirical Study of Resource Management Dynamics

Abstract

The Resource-based view (RBV) of a firm is a stream in the field of strategic management. System Dynamics scholars have made a number of contributions towards the field by seeing a firm as a resource system rather than a bundle of resources. This perspective, known as the Dynamic RBV, emphasizes on the importance of managing the firm's resource system. This paper follows the Dynamic RBV perspective and examines the resource management process under causal ambiguity; the study hypothesizes that systemic understanding towards the resource system helps the management behavior. Then, the paper empirically tests the hypotheses via a behavioral experiment design. Two controlled groups, each with a different understanding of the resource system, are compared. Using a management flight simulator, People Express 2000, 60 participants engaged in a resource management process of a low-cost airline. The study shows that employing system's perspective towards the resource system supports managers to effectively manage their resource system and also improves performance.

Key words: Dynamic Resource-based view, System's thinking, Decision behavior

Introduction

Over the years, System Dynamics scholars have contributed to the Resource-based view (RBV) of strategic management field (Barney 1991) by using system's thinking and modeling approach (Morecroft 2002, Morecroft 2007, Kunc and Morecroft 2010); the combination of System Dynamics and the RBV is referred as the Dynamic RBV. The Dynamic RBV scholars view a firm as a resource system that needs to be managed over time. Strategic resources, which are responsible for the firm performance, are depicted as stocks and the level of resources are determined by the attached flows to them. The auxiliaries and causalities represent the various operating policies and external factors that influence the resource accumulation processes (Kunc and Morecroft 2009). Through this System Dynamics approach, the Dynamic RBV appoints that the performance of a firm is driven by the managers' resource system management behaviors (Morecroft 2008). This paper follows the Dynamic RBV perspective; in particular, I investigate resource management process under causal ambiguity (King 2007). Adopting the system's perspective, I propose that causal ambiguity adversely affect managers' understanding in the system of complexly intertwined resources[1]. Where the varying degrees of systemic understanding towards the resource system would create performance heterogeneity between firms, I propose that system's thinking would enhance the systemic understanding of the resource system. As a result, the system's thinking can help managers to ameliorate their resource management behavior, as well as performance. This notion is empirically tested in this paper via four hypotheses.

[1] The sister paper, "*Strategic Resource Management under Causal Ambiguity – The Dynamic Resource-based view approach"*, has theoretically discussed this issue thoroughly, and presented five theoretical propositions. It was anticipated that system's thinking would help managers to manage resources in a more effective manner.

Hypotheses

Seeing a resource system with a system's perspective can support managers to effectively manage their resources. A resource management process is often challenged by causal ambiguity (Kunc and Morecroft 2010); managers often misinterpret the resources' interrelationships and thus make ineffective decisions. By having a systemic understanding of the resource system, managers can appreciate the causal effect of their decisions and thus experience less causal ambiguity of the firm resource system during management of these resources. The following hypothesis was created, based on the above notion:

H0. A manager who possesses a systemic understanding of the interrelationships between resources will exhibit less causal ambiguity regarding the firm's resource system than one who understands resources as discrete resources.

The causal ambiguity regarding the resource system hinders managers in correctly comprehending the working of their resources (King 2007). If a manager does not possess appropriate knowledge of the firm's resource system, the manager may make wrong decisions in an attempt to develop a strategic resource (Kunc and Morecroft 2009); this will result in an unexpected outcome which may be different from the decision maker's initial expectation. Hence, a manager who experiences less causal ambiguity will comprehend the working of the resource system better and thus is expected to make more effective decisions than one who experiences a high level of causal ambiguity.

The idea of cognitive overload (Kirsh 2000) can also cause potential performance gap between the managers with systemic and discrete understanding. Managers who attempt to develop strategic resources develop two levels of understanding (Kunc and Morecroft 2010). First, relevant resources, factors and their relationships are conceptualized (resource conceptualization). Secondly, the resources' specific flow-rates (Sterman 2002) that are imposed on each relationship are understood through goal-seeking behavior (resource management) (Morecroft 2002, Kunc and Morecroft 2009). Using this knowledge, the gap between current and desired level of resources can be narrowed. During resource management processes, managers with a systemic understanding only need to develop the understanding of the specific flow-rates that are attached to resources. On the other hand, managers without systemic understanding of the resource system need to improve their understanding of the relationship between the resources from their resource management decision feedbacks. However, managers' perceptions of the decision feedback are likely to be unreliable due to "misperceptions of feedbacks" (Sterman 1989a, Sterman 2000). Taking this into consideration, the task of conceptualizing the interrelationships of the resources and their specific flow-rates simultaneously can exceed the managers' cognitive processing capacity, causing cognitive overload (Speier, Valacich, and Vessey 1999, Kirsh 2000); this is expected to adversely affect the decision effectiveness.

Based on the above two theoretical ideas, the following hypothesis is proposed:

H1. A manager who experiences less causal ambiguity in the resource system would enjoy superior performance than a manager experiencing high level of causal ambiguity.

The difference in performance can be attributed to different resource accumulation behavior. Managers develop resources based on managing the rate of the inflow and outflow of the resource level: this decision behavior is named *purposive adjustment behavior* (Morecroft

2002, Kunc and Morecroft 2010). A manager who exhibits less causal ambiguity is likely to know how to accumulate a resource, thus he or she will be able to control the resource system effectively through comprehending the effect of his or her decisions. This systemic accumulation behavior is termed *proactive resource management behavior* (Morecroft 2002). Conversely, managers who do not possess this understanding will be slower to accumulate the resource as they will need to improve their understanding of the working of the resources before they can initiate proactive resource management behavior. These managers are first likely to engage in *hypothesis testing decision behavior* (Mosakowski 1997), where they make a set of rules and test them, then learn from the outcome and revise their decision. A recent SD literature discusses a similar notion, namely *exploratory modeling* (Pruyt 2007). Exploratory modeling practice refers to a phase where modeler makes models to explore a highly uncertain and complex problem situation before developing an ideal policy (Pruyt and Hamarat 2010). Both hypothesis testing behavior and exploratory modeling represents a sense-making behavior before exhibiting a purposeful and rational decision behavior. The following hypothesis originates from this idea:

H2. A manager who experiences high causal ambiguity over a resource system will exhibit hypothesis testing behavior for longer than a manager experiencing lower causal ambiguity.

Lastly, having a systemic understanding is expected to support managerial learning over time. It has been argued that having a model can be used as an effective learning tool (Morecroft 1984, Graham et al. 1992, O'Brien and Dyson 2007). By having a model of a system, a manager can build their understanding in the concept of stock and flow as well as the idea of feedback loops (Morecroft 2007). Through the accurate identification and understanding of the feedback loops, managers can interpret better their decisions; this helps managers to be less susceptible to misperceptions of feedback (Capelo and Dias 2009). Through the accurate interpretation of the feedbacks, managers can improve their decisions over time, helping their managed firm to become a learning organization (Senge 2006). Based on this, the following hypothesis is presented:

H4. *A manager with a systemic understanding of a resource system would improve their decision behavior and performance more effectively than a manager without such understanding*

Study methods

The study employs an experiment using two control groups. Participants managed a low cost airline through the use of a management flight simulator; one group was given a complete understanding of the causal linkages between the resources and the other group was not given this information. Each participant's mental model and resource management behaviors were retrieved using questionnaires; in addition, their decisions and performances were recorded by the simulator for analysis. With the data, the study quantitatively contrasted the two groups in terms of their decision behavior and performances.

Data collection methods for RQ3

The experiment was conducted using 60 participants. Those invited to participate were students from a university-based business school. All invited participants were business

school students in order for them have a basic knowledge of how to manage a firm. Participants were invited to join and play a management flight simulator, the People Express management flight simulator (Bakken, Gould, and Kim 1992, Sterman and Morrison 1988, Morecroft and Sterman 2000). The participants were randomly divided into two groups; both groups were given an identical task under identical conditions, but the experiment was designed to give one group a more systemic understanding of the resource system than the other group.

The purpose of the study was to empirically test the four hypotheses, where the cause of firm heterogeneity is attributed to the difference in the systemic understanding of a causally ambiguous resource system. In order to empirically test the propositions, the following settings were set:

1. All possessed resources are identical across the subjects; that is, every subject has the same resource set, and all are granted equal access to develop and manage the resources.
2. Because all subjects are managing the identical resource system, the causal ambiguity experienced by one firm can potentially be experienced by every other subject in the experiment.
3. Reflecting the endogenous view of the RBV, the decision outcome is driven by decision makers' resource development strategy, not by the exogenous variables. Hence, the type of causal ambiguity is 'causal ambiguity in resource system.

Task

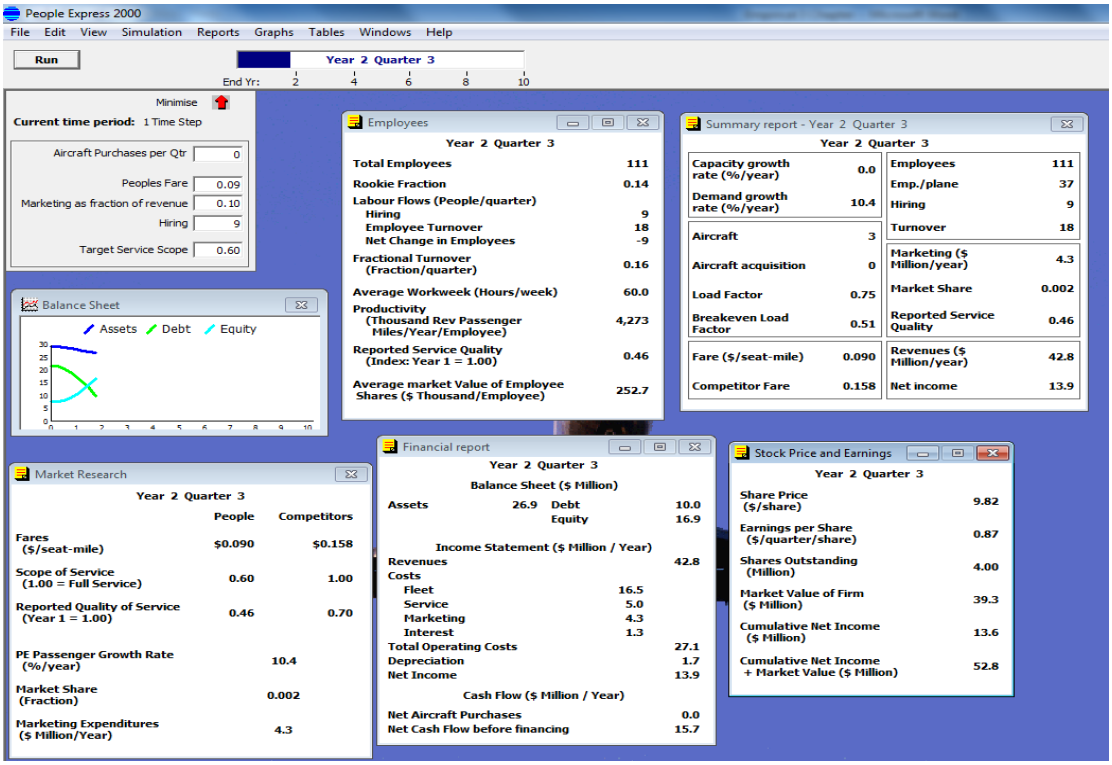

Figure 1: A screenshot of the typical game screen

People Express 2000 is a management flight simulator where a player is required to make quarterly business decisions for a ten-year game period (40 decisions), unless the firm files

for bankruptcy. Business decisions include aircraft purchase, fares, marketing spending, hiring, and service scope. Figure 1 shows a typical game screen. As can be seen from the figure, there is a large array of information available, and the decision maker chooses which information he or she will load and attend to.

The objective of the game is to maximize accumulated profit in the given time period of ten years. The firm files for bankruptcy when the equity of the firm drops below zero. Figure 2 shows the System Dynamics model of the game, which depicts the resource system of People Express (referred as the resource map hereafter). As can be seen from the model, the resource system of People Express is causally ambiguous due to its highly complex and dynamic nature; the following describes some of the many non-linear feedback loops and factors which hinder the decision makers' understanding of the resource system.

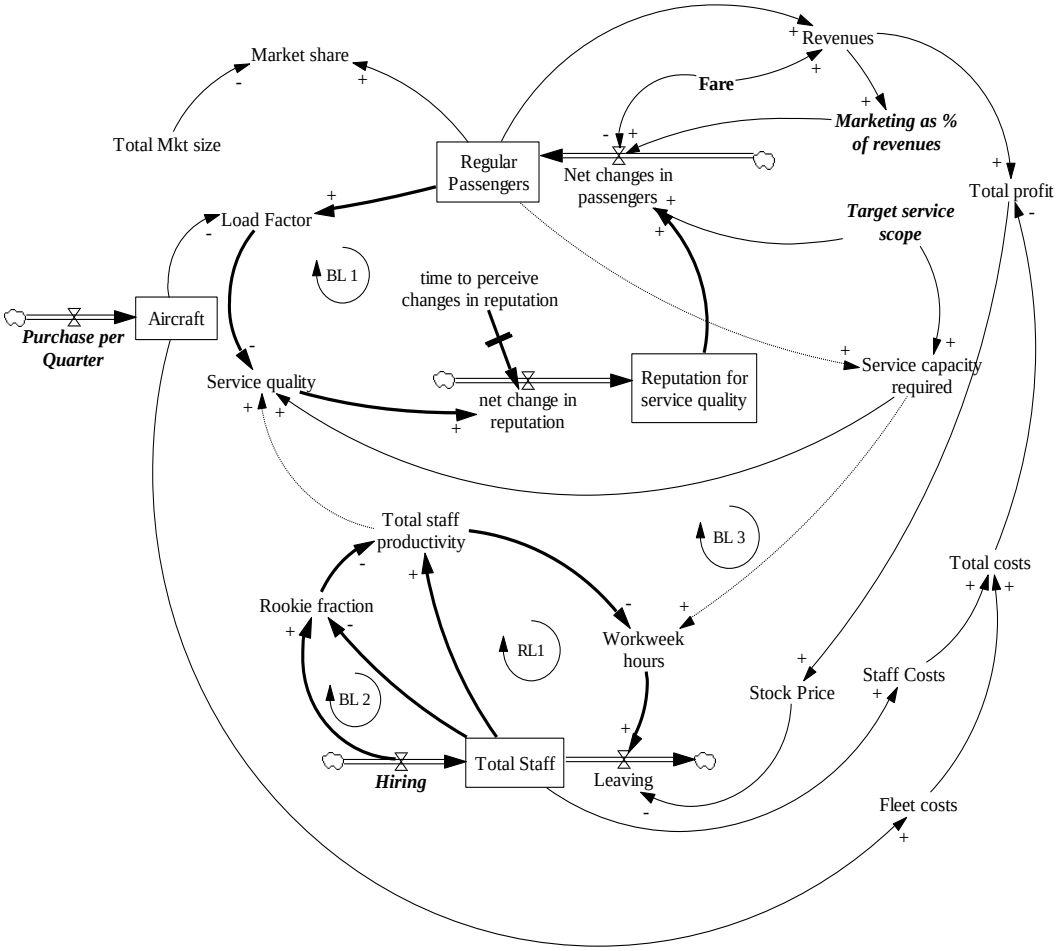

Figure 2: Resource map of People Express

Balancing Loop (BL) 1 (Loop is shown as a bold line): An increase in regular passengers leads to an increase in the load factor. This decreases the service quality. The drop in service quality will lead to a fall in the net change of reputation, which then leads to regular passenger loss.

Balancing Loop 2 & Reinforcing Loop 1 (BL2 and RL1) (Loop is shown as a bold line): The decision maker can hire extra staff to increase the total number of staff, which positively affects total staff productivity; this reduces workweek hours,

leading to less loss of staff. However, hiring new staff also raises the Rookie fraction, which negatively influences the productivity; this increases workweek hours thus decreases the number of staffs. In short, a decision maker will need to employ management tactics which expand his/her business while finding a balance in the number of employees.

Balancing Loop 3 (BL) (Loop is shown as a dotted line): A rise in the number of regular passengers increases the required service capacity, leading to an increase in the number of hours in the working week of the staff. Increased working hours will cause staff to leave, which in turn decreases service quality via reduced staff productivity. Such a decrease in the service quality will cause a fall in the number of regular passengers.

Taking into consideration the above loops, a complex challenge exists for the management of the resource system. A sustainable growth in regular passengers is difficult to achieve as any increase in the number of regular passengers must be supported by the service capacity. Overall, the information that is available to the decision makers may reveal the causal effect of their decisions; but decision makers need to make sense of the resource system's interrelationships in order to fully comprehend the impact of their decisions.

Procedures

To design an experiment in a robust manner, I referred publications in leading journals that had used a System Dynamics-based model as the game by which to collect the data (Sterman 1989b, Kunc and Morecroft 2010, Gary and Wood 2011, Gary, Wood, and Pillinger 2012). With reference to previous research, the data collection procedure was created. The following is the data collection procedure.

1. Participants were recruited to play People Express. The participants were promised some financial benefit for participating (Gary and Wood 2011) with an additional financial prize for the winner; the cash prize was used as a means of increasing the level of interest to participate.
2. Once a participant had accepted the invitation, a questionnaire was sent to require him/her to fill in certain demographic attributes (age, business experience, area of interest).
3. Once the participants arrived for the experiment, there was a ten minute introduction/briefing, explaining the People Express airline, and the idea of causal linkages.
4. After the introduction, the participants were given a material to refer to. Members of group A were given a completed resource map of the firm, whereas Group B received a list of resources and external/key success factors. With different materials to hand, the participants started their practice sessions where they were given instructions on how to make business decisions and read performance measures. Following this instruction, the participants engaged in a practice session. This practice session took a maximum of 20 minutes and helped the participants to get used to the interface of the game.
5. The participants played the game three times at their own pace, where all decisions were recorded. The participants were asked to assume the firm would continue to

exist even after the ten year period; they were warned that resource disposal behavior at the end of the game would disqualify them. In those cases where the participant did not go bankrupt, I collected 120 decisions per participant through three trials. The three games were categorized into Trials 1, 2 and 3, and decisions from each trial were only compared against the decisions from the same trial. These distinctions in the three trials were made in the expectation of controlling the learning effect of the participants. In sum, 180 runs (60 participants * 3 games), and the maximum number of 7,200 (180 run * 40 decisions per game) decisions were collected for analysis.

6. Once the participants had completed the game, they answered questions on which resource they had focused on developing, and their time taken to reach proactive resource management behavior.
7. After the session, I collected the resource maps/resource lists. The participants completed a questionnaire measuring accuracy of understanding of the competitive environment. Having completed the questionnaire, they were paid before leaving.

Measures

Understanding of the causally ambiguous resource system (for H0): The participants' degree of experiencing causal ambiguity was evaluated by measuring their understanding of the causal relationships in the resource system via bi-relationship test (Gary and Wood 2011). I presented them with a set of variables where they were asked to fill in the relationships between the variables; the choice was either +, - or no direct relationship (See Questionnaire 3 in Appendix). There were a total of 34 causal relationships in the resource system. Hence the participants' understanding was marked out of 34. A lower score meant experiencing more causal ambiguity.

Performance and its variance between the two groups (for H1): Performance was measured by the accumulated profit at the end of each trial. The mean accumulated profits of the two groups were used to test the performance difference between the two groups.

Decision behavior (hypothesis testing behavior: For H2): Hypothesis testing behavior was measured by calculating the period of time which lapsed before a participant reached a stable state of resource management, namely, proactive resource management behavior (Morecroft 2002). The participant was asked to give a time that took them to start the proactive resource management behavior (See Questionnaire 2 in Appendix). The two groups' times to reach proactive resource management behavior were compared to see which group employed a longer time period of hypothesis testing behavior.

Control variables: Based on past literature (Hambrick and Mason 1984), I set a number of demographic variables could potentially affect the performance of the decision makers as control variables. The participants' ages and work experience (Norburn and Birley 1988, Finkelstein and Hambrick 1990, Finkelstein, Hambrick, and Cannella 2009) were collected (See Questionnaire 1 in Appendix). The control variables were computed to see if they could provide an alternative explanation to the hypotheses for performance heterogeneity between the decision makers.

Analysis and Result

Analysis method

Statistical analysis was used to compare two groups, Resource List group (RL group) and Resource Map group (RM group). Hypotheses were tested via non-parametric Mann-Whitney test; the method compares the medians instead of the means of two independent samples. The test is considered robust when applied to small sample studies as it does not make a strong assumption that the sample is normally distributed (Palepu 1985). Using the Mann-Whitney test, I employed one-tail hypothesis tests as all hypotheses were testing the direction of the two independent samples (Daniel and Terrell 1995). The three trials were analysed separately (Gary and Wood 2011); this was to ensure that the analysis was free from the potential bias of learning effect, as a participant played each round of the game based on the knowledge that he or she had acquired during the previous trial.

Testing Hypothesis 0

Hypothesis 0 was tested by conducting a Mann-Whitney test on the causal understanding scores that were retrieved via Questionnaire 3 (see Appendix) which asked the participants to identify the causal relationships from the 34 potential relationships. The participants' score was divided by 34, therefore the maximum score was 1.

	Median	Max value	Min value	n	Mann-Whitney test	
					Mann-Whitney U	Exact Sig. (1-tailed)
RL	0.273	0.879	0.121	30.000	209.000	0.000
RM	0.545	0.970	0.152	30.000		

Table 1: Mann-Whitney test for causal understanding comparisons

As can be seen from Table 1, RM group statistically scored significantly higher than RL group. This showed that the RL group exhibited more causal ambiguity regarding their resource system; hence H0 was supported. Through the confirmation of the hypothesis, the study confirmed that the two groups differed in experiencing causal ambiguity in managing the resource system, with RL group experiencing more causal ambiguity than RM group. However, even with the provision of the resource map, the RM group managers did not exhibit perfect understanding of the resource system (The score that represents the perfect understanding would be 1.00). Therefore, it is worth noting that the provision of the resource map helped managers to experience less causal ambiguity, but only marginally eliminated the causal ambiguity in many cases.

Testing Hypothesis 1

Hypothesis 1 was tested by comparing the performance medians of the two groups via the Mann-Whitney test (Table 2).

		Median	Max value	Min value	N	Mann-Whitney test	
						Mann-Whitney U	Exact Sig. (1-tailed)
Overall	RL	71.17	653.21	-37.55	90	2331.500	.000
	RM	183.08	1341.9	-33.09	90		
Trial 1	RL	31.22	483.99	-37.55	30	312.500	.021
	RM	105.64	603.79	-33.09	30		
Trial 2	RL	78.81	435.28	-28.55	30	229.500	.000
	RM	203.06	1119.6	-13.84	30		
Trial 3	RL	114.82	653.21	-19.54	30	201.500	.000
	RM	253.73	1341.9	-22.65	30		

Table 2: Mann-Whitney test for performance median comparisons

Hypothesis 1 was confirmed. The Overall, Trial 1, Trial 2, Trial 3 performances of the two groups were significantly different. RM group outperformed RL group in all trials, and the performance gap grew wider over the trials. Figure 3 shows the change in the performances of the two groups.

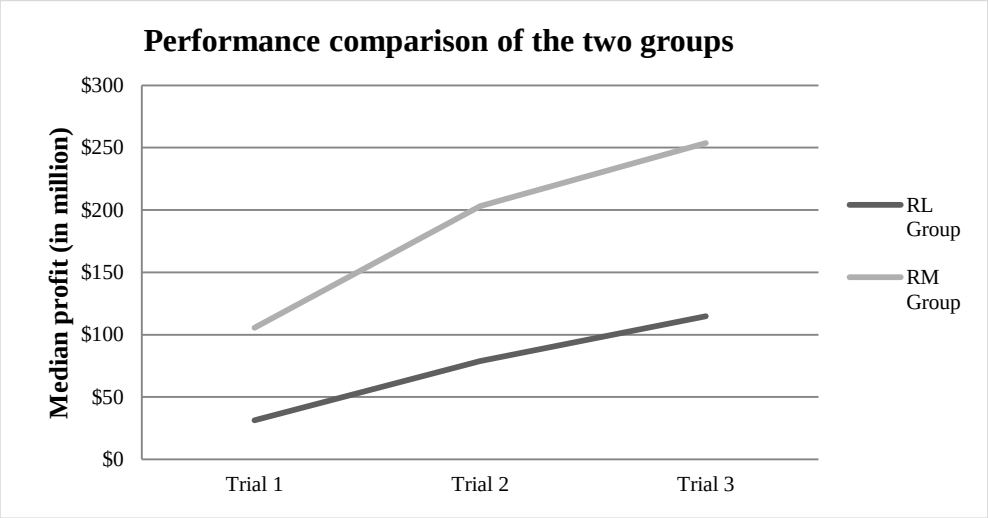

Figure 3: Performance comparisons over time

Testing Hypothesis 2

Hypothesis 2 was tested by conducting the Mann-Whitney test on participants' responses in terms of the time taken to reach the appropriate decision. The five decision fields were matched separately. As Table 3 indicates, participants of the RL group took a significantly longer period of time to reach a satisfactory decision. The only decision field that did not demonstrate any significant statistical difference in the time taken by the two groups was the decision field of Target service scope in Phase 1. The variance in the time grew in significance as the trial progressed. Based on the result, I concluded that the hypothesis was mostly confirmed except for Phase 1.

	Variables	Group	Median	Max	Min	Mann-Whitney test		
						n	Mann-Whitney U	Exact Sig. (1-tailed)
Overall	Airplane	RL	5	10	1	90	2671.5	.000
		RM	3	10	1	90		
	Price	RL	5	10	1	90	2424.5	.000
		RM	3	10	1	90		
	Marketing	RL	5	10	1	90	2685.5	.000
		RM	3	10	1	90		
	Hiring	RL	5	10	1	90	2589	.000
		RM	3.5	10	1	90		
	Service	RL	6	10	1	90	2420	.000
		RM	3	10	1	90		
Trial 1	Airplane	RL	6	10	2	30	264.5	.003
		RM	4	10	1	30		
	Price	RL	6.5	10	2	30	283.5	.006
		RM	5	10	1	30		
	Marketing	RL	6	10	2	30	336.5	.046
		RM	4.5	10	1	30		
	Hiring	RL	6.5	10	3	30	309	.018
		RM	4.5	10	1	30		
	Service	RL	6	10	2	30	387.5	.178
		RM	5	10	1	30		
Trial 2	Airplane	RL	5.5	8	1	30	299.5	.012
		RM	3	8	1	30		
	Price	RL	5	9	1	30	271	.004
		RM	3	8	1	30		
	Marketing	RL	5	8	1	30	312	.019
		RM	3	7	1	30		
	Hiring	RL	5.5	10	1	30	306.5	.016
		RM	3	8	1	30		
	Service	RL	6	9	1	30	280.5	.005
		RM	3	9	1	30		
Trial 3	Airplane	RL	3	6	1	30	302.5	.012
		RM	2	5	1	30		
	Price	RL	5	7	1	30	215.5	.000
		RM	2	7	1	30		
	Marketing	RL	3	7	1	30	232.5	.000
		RM	2	5	1	30		
	Hiring	RL	5	7	1	30	198	.000
		RM	2	6	1	30		
	Service	RL	5.5	7	1	30	89	.000
		RM	2	5	1	30		

Table 3: Mann-Whitney test to compare time to reach appropriate decision

Testing Hypothesis 3

The last hypothesis, H3, was assessed to see if having a resource map helped the group to experience a stronger learning curve over time. Performance of participants (H1) and time

taken to reach proactive resource management behaviors (H2) were tested. The hypothesis was accepted if the median difference between the two groups grew and the significance level lessened over the trials. H3 was fully accepted. The median difference between the two groups increased and the significance level between the two group's mean performances decreased over the trials (Table 4). This implied that the RM group was able to more dramatically improve their performance over the phases than the RL group.

	Trial 1	Trial 2	Trial 3
Median difference	74.42 (RM >RL)	124.25 (RM >RL)	138.91 (RM >RL)
Exact Sig. (1-tailed)	.021	.000	.000

Table 4: Performance variance of the two groups over trials

The time taken by each of the two groups before demonstrating proactive resource management behavior was also computed to see if the RM group took less time over the course of the trials (Table 5). The hypothesis was partially confirmed. For Price, Hiring, and Service variables, the median difference increased and the significance level decreased over the trials, fully supporting the hypotheses. For both the Airplane Purchase and Marketing variables, there was an increase in the median difference between Trial 1 and Trial 2, but the median discrepancy decreased in Trial 3. However, the significance level reduced continuously over time for Marketing, whereas the Airplane Purchase variable saw an increase in the significance level over the trials. In short, H4 was mostly supported except for Airplane purchase. These findings indicated that the RM group, in comparison to the RL group rapidly decreased the hypothesis testing behavior over the trials. There was one exception for Airplane purchase behavior, where the RL group reduced their hypothesis testing behavior time at a faster rate than the RM group.

Time to reach proactive resource management behavior median difference (Calculated via RL – (minus) RM)			
	Trial 1	Trial 2	Trial 3
Airplane	2	2.5	1
Price	1.5	2	3
Marketing	1.5	2	1
Hiring	2	2.5	3
Service	1	3	3.5
Exact Sig. (1-tailed)			
	Trial 1	Trial 2	Trial 3
Airplane	.003	.012	.012
Price	.006	.004	.000
Marketing	.046	.019	.000
Hiring	.018	.016	.000
Service	.178	.005	.000

Table 5: Two groups' variance in time to reach the proactive resource management behavior over phases

Lastly, I ran a multiple regression with the control variables to see if the control variables provided an alternative explanation for the performance variances between the two groups. As can be seen from Table 6, none of the control variables had a statistically significant

relationship with performance; I concluded that there was no evidence that control variables affected the performance of the participants in this experiment.

	Regression results for Resource list group				**Regression results for Resource map group**		
R^2	0.095				0.133		
Adjusted R^2	0.017				0.059		
	Unstandardized Coefficients				Unstandardized Coefficients		
	Beta	Std. Error	Sig.		*Beta*	Std. Error	Sig.
(Constant)	128.486	38.377	.001		302.914	140.483	.034
Age 20-24	-130.848	99.337	.191		390.690	268.935	.150
Age 25-29	-46.365	97.553	.636		168.082	240.752	.487
Age 30-34[2]	-140.539	84.155	.099		-20.538	223.608	.927
Experience: 0 years	128.701	91.597	.164		-404.583	304.162	.187
Experience: 0-4 years	76.284	88.714	.392		-48.503	277.903	.862
Experience: 5-9 years[3]	95.238	89.199	.289		-74.732	216.975	.731

Table 6: Regression results with control variables

Discussion

The empirical analysis generally confirmed the proposed hypotheses. Based on the results, I propose the following theoretical framework, Figure 4 in a presentation of a causal loop diagram.

R0 shows the feedback loop between knowledge of the resource system and causal ambiguity. Causal ambiguity hinders managers in their understanding of the resource system, but once they do understand, causal ambiguity is reduced. (King and Zeithaml 2001, Powell, Lovallo, and Caringal 2006). Improved systemic understanding positively affects managerial decision quality. This echoes past System Dynamics literature that found the system's thinking supports organizational performance (Capelo and Dias 2009).

R1 and R2 show the reinforcing process of the performance improvement through managerial learning. The loops depicts how causal ambiguity is reduced over time, through the continuous decision processes of feedback and managerial learning (Dyson 2000, Senge 2006) through increased knowledge (R1). The increased knowledge will shorten hypothesis testing

[2] Reference category for age category was "age 35 or older"

[3] Reference category for experience category was "10 years or older"

behavior (R2). Following these loops, managers improve their decision quality and performance over time.

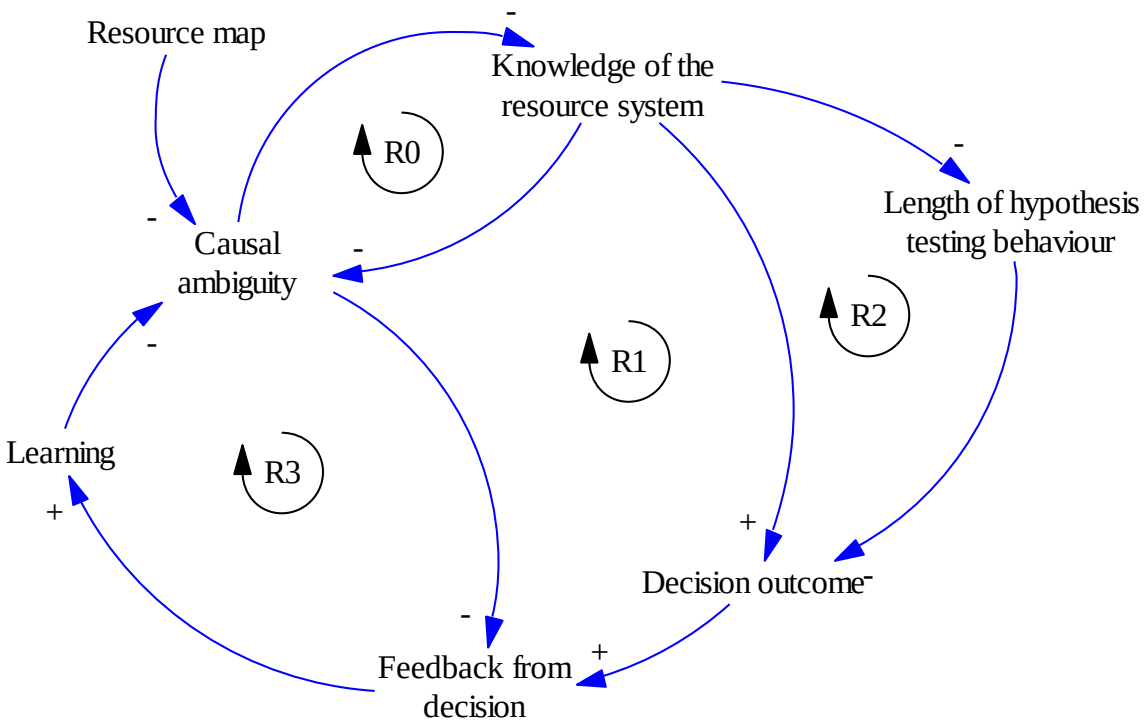

Figure 4: Theoretical framework on causal ambiguity over resources system

R4, on the other hand, shows the difficulty of reducing causal ambiguity; it shows how causal ambiguity causes decision makers to misperceive feedbacks (Sterman 1989b), which then hinders managerial learning. In essence, R1 and R4 depict the two feedback processes that decrease and increase causal ambiguity over time respectively.

The difference between the two groups lay in the provision of the resource map. The map enabled the managers to adopt systems perspective towards the resource system, which helped them to reduce the causal ambiguity surrounding the resource system. With the map, the RM group was under the stronger influence of Loop R1. Having the resource map helped them to quickly make sense of the resource system, and their understanding was reinforced through continuous managerial learning. Conversely, RL group, without the map, experienced a higher level of causal ambiguity than RM group. With this higher level of causal ambiguity, Loop R4 was more dominant than Loop R1 within their decision processes. Hampered by their misperception of feedback, they struggled to establish an understanding of the resource system. Therefore, despite the fact that R1 and R4 were both reinforcing loops, R1 and R4 acted as a positive and negative reinforcing loop respectively (Senge 2006), where R1 acted as a positive reinforcing loop increasing the knowledge of the decision makers' resource system over time, and R4 acted as a negative reinforcing loop, slowing the decision makers understanding of the resource system. Based on this effect, the performance gap grew over the trials. This study confirms that having a system's perspective indeed helped managers to manage their resource system.

Conclusion

This study presented a comprehensive investigation into the role of a clear systemic understanding of causal linkages during resource management and development processes. The behavioral simulation proved that having a systemic understanding of the resource system helps managers to exhibit less causal ambiguity regarding the resource system; two main ideas of the paper are discussed.

Firstly, the paper, through System Dynamics approach, successfully illustrated the performance heterogeneity between firms. That is, following the Dynamic RBV (Kunc and Morecroft 2010), the paper showed how firms exhibit heterogeneous performance based on their different resource management behaviors. Such Dynamic RBV perspective presents an enriched explanation of the resource-performance relationship than the traditional RBV, as the performance can be attributed to accumulation, feedback-process and management behavior over time, rather than simply attributing a performance to a possession of a resource.

Secondly, the study found that systemic understanding help managers to improve their performance. What's worth to note is that the resource map only limitedly helped managers to improve their understanding of the resource system. However, the study shows that even employing a very basic form of system's perspective significantly helps managers in managing resources. This conforms to System Dynamics studies that propose that adopting system's thinking can highly improve the strategic thinking (Capelo and Dias 2009, Kunc 2012). Strategic Modeling, or modeling for learning (Morecroft 2007) can support the systemic conceptualization process.

In overall, I see that adopting system's approach can strongly ameliorate the field of RBV and the field of strategic management by enhancing the explanatory power of firm heterogeneity. Also, I see that nurturing managers to develop system's thinking can strongly support managers to manage their organizations.

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Appendix

Questionnaire 1

1. Name:
2. Age:
3. Gender:
4. Education
    a) Current education major:
    b) Previous education major (if applicable):
5. Career experience (if applicable)
    a) Years of experience:
    b) Functional background:
6. Area of interest (Please state the function in business that you are most interested or the business module that you enjoy the most)
    a) Strategic management and business expansion
    b) Finance and pricing
    c) Marketing
    d) HR management
    e) Service management

Questionnaire 2

For this simulation, please specify the time it took to reach the satisfactory decision. A satisfactory decision refers to decision that was expected give a sustainable growth without breaking the balance against other variables.

	Years to reach the appropriate decision									
	0-1 years	1-2 years	2-3 years	3-4 years	4-5 years	5-6 years	6-7 years	7-8 years	8-9 years	9-10 years
Aircraft purchase										
Fare										
Marketing spending										
Hiring										
Service scope										

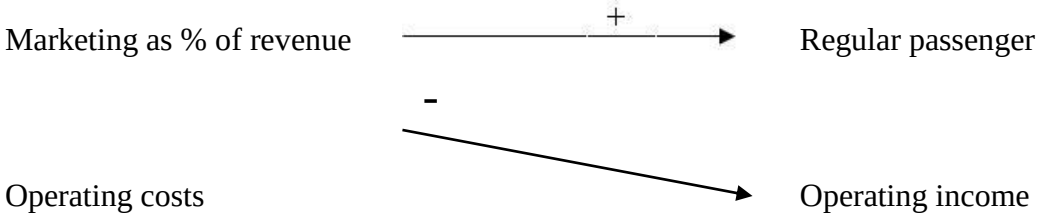
If you chose an option apart from 6 from the above question, please rank the decision fields from the one that you have focused the most to the least.

Please state the level of attention you have paid to each of the following decision field. I you have fully focused to the decision field, tick 7. If you have not paid any attention to the decision field, please check 1.

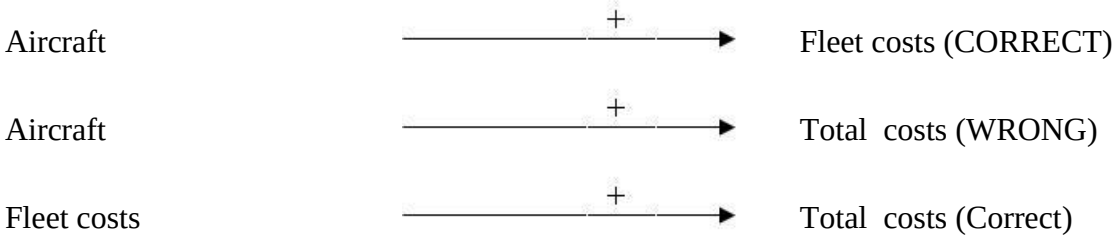
	Did not focus 1	2	3	4	5	6	Fully focus 7
1. Aircraft purchase							
2. Fare							
3. Marketing as a fraction of revenue							
4. Hiring							
5. Target service scope							

Questionnaire 3

Please draw influence arrows between all the variables that you believe there is a **DIRECT RELATIONSHIP**. You should not draw the arrows between the variables that seem to have indirect relationship. The following two examples show the two types of relationship; positive and negative. Positive relationship is a relationship where increase in one variable leads to increase of the other variable (decrease leads to decrease). Negative relationship represents a relationship where increase in one variable decreases the other variable (decrease leads to increase).



Again, it is important that you only draw a line on a direct relationship. The following illustrates the example of direct and indirect relationship.



You are expected to draw the influential arrow as well as polarities between the variables. If you are unsure about the relationship, write a question mark next to the variable instead of guessing.

Remember there can be more than one relationship per variable.

(Turn the page for the set of variables)

Aircraft

Fare

Fleet costs

Hiring

Load factor

Market share

Marketing as % of revenue

Total costs

Total profit

Regular passenger

Reputation for service quality

Revenues

Rookie fraction

Service capacity required

Service quality

Staff costs

Stock price

Target service scope

Total market size

Total staff

Total staff productivity

Workweek hours

Aircraft

Fare

Fleet costs

Hiring

Load factor

Market share

Marketing as % of revenue

Total costs

Total profit

Regular passenger

Reputation for service quality

Revenues

Rookie fraction

Service capacity required

Service quality

Staff costs

Stock price

Target service scope

Total market size

Total staff

Total staff productivity

Workweek hours