Improving Professional Practice for Mobile Operators through the Development of a Decision Support Tool for Outsourcing

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Abstract **- In recent years mobile operators have been facing many challenges including fierce competition between operators due to increased market saturation, competition with Over-The-Top (OTT) providers and ever-growing regulatory policies. While the advent of new technologies such as 5G, Internet of Things (IoT) and Artificial Intelligence (AI) present new growth opportunities, they also come with their own cost and operational challenges. All the above developments inevitably is putting pressure on the opera-tors' costs and profitability. Because of changing market dynamics, reducing costs and maintaining profitability are the key issues on top of operators' agendas. Outsourcing has emerged as an effective strategic tool for these opera-tors to address these issues. The unrelenting pressure for greater efficiencies has forced many operators to increasingly focus on their core competencies and hence, specialize in a limited number of key areas. This has led operators to outsource some activities that traditionally have been carried out in-house. This research investigates how to facilitate the outsourcing decision that could change the entire strategy and positioning of the operator. The aim of this paper is to develop simulation-driven decision support tool for outsourcing that helps the executives and practitioners in the mobile operators to make an adequate decision with minimal risk. The simulation-driven tool may also be of interest for academics or researchers in the field.**

Keywords - Mobile Operators; Outsourcing Models; Decision Tool; System Dynamics;Powerism Simulation

I. INTRODUCTION

Many of the mobile network operators were established in the era of 2G mobile technologies. These operators built up internal knowledge of network operations and cooperated with equipment vendors in net-work management since the beginning of their network rollout.

Most mobile operators view their physical network as a main differentiator vis-a-vis other mobile network operators, including virtual ones as well. Accordingly, many consider their network an important strategic asset (Friedrich et al. 2009). As a result, while mobile operators are vigorously undertaking the outsourcing of network operations services, many choose to continue to claim legal ownership of the underlying assets and choose to continue owning the responsibility for the associated strategic decisions (Anderson and Williams 2004).

Typically, mobile operators decide to outsource less critical functions like field services or inventory management as a first step. If successful, they will extend the initial contract to include a larger scale of network operations functions (Friedrich. et al. 2009). This is usually possible given the long term contracts associated with network operations services outsourcing, which typically run between three and five years.

Finally, in an effort to continue to squeeze the operational costs, some operators are exploring sharing their physical infrastructure with other operators to create one common network infrastructure, which can be managed by one external provider. If this trend takes hold, it will make the case for outsourcing net-work operations services even more compelling.

One of the key questions to be answered is: can a mobile operator achieve its key performance indicators (KPIs) in the future or should it outsource them? In both cases, there is a degree of uncertainty. The benefit of outsourcing is that the company can target cost savings, efficiency and better performance but there are downsides in so far as once talent leaves the company, it takes time to replace it, if needed.

Focusing on that perspective, three basic factors have to be considered:

1) The choice of partners – higher complexity, specialization and the division of labor make it possible for the outsourcers to carry out several activities with lower costs and a higher added value, than in the case of carrying out all activities inside the company; the outsourcing company chooses suppliers, who improve the outsourcer's position in the market through their knowledge, capabilities and technology.

2) The consequences of short-term placement – the majority of companies are typically driven by short-term results (primarily financial results) of the outsourcing relationship. They are rarely aware of the long-term consequences of their actions, thus it is necessary to study the use of capabilities brought about by establishing and termination outsourcing activities and compare them in a temporal framework with the benefits for both the outsourcer and outsources.

3) The consequences of eventual termination of outsourcing – the review of literature indicates that

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enterprises rarely deal with the challenges that arise when a company decides to terminate outsourcing activity and bring the activity back in-house. Thus, it is necessary to find out if the outsourcing company still has the equipment and professional staff who is familiar with the processes, financial assets etc. or the position in which the outsource may find itself in.

This paper describes an attempt to couple the power of computer modelling with the judgement of an experienced practitioner to build a decision-making tool for outsourcing in the mobile industry.

II. THEORETICAL FOUNDATIONS

The majority of outsourcing models are based on three main theories:

- Transaction Cost Economics (TCE)
- Resource Based View (RBV)
- Agency Theory.

A number of outsourcing studies in the telecoms in-dustry have employed either Transaction Cost Economics (TCE) as Edoardo Mollona & Alessandro Sposito (2008) [1], Jacobides, M.G. and Winter, S.G.(2005) [2] Jiang, B., Belohlav, J. Young, S. (2007) [3], or Resource-Based View (RBV) as Lowson (2002) [4] , Coates and McDermott (2002) [5] , Vastag, (2000) [6], Aron, R., Singh, J.V.(2005) [7] , Ellram et al.(2008) [8] , Youngdahl and Ramaswamy (2008) [9] or Agency Theory as Logan, Mary S (2000) [10] as theoretical frameworks to undertake their analysis.

A. Transaction Cost Economics (TCE)

Following transaction costs economics (TCE), external suppliers can achieve production cost efficiencies through economies of scale and specialization (Marshall et al. 2007) [11], which provides a motive for outsourcing (Poppo and Zenger 1998) [12]. How-ever, other costs related to the exchange of services within or across firm boundaries, such as search, se-lection, bargaining, monitoring and enforcement (Madhok 2002) [13], may offset the production cost savings of external suppliers given the higher likelihood of opportunistic behavior of an external supplier compared to an internal unit (Williamson 1991) [14]. Frequency, asset specificity, and uncertainty are the key drivers of transaction costs.

External suppliers build Global Network Operations Centers to serve the networks of many customers. These few but large operation centers presumably work more efficiently than the sum of all small operation centers managed by and serving single network operators. This is in part due to fixed costs, for exam-ple in problem-solving teams. Suppliers serving sever-al networks need only one such team as network breakdowns rarely occur simultaneously in multiple networks. Hence, specialized external suppliers can offer network operation services at lower cost than internal departments at operators (Hecker and Kretschmer 2010) [15].

For transaction costs, Crandall et al. (2009) [16] argued for the telecommunications market that negotiating issues such as “prices for maintaining the network, connecting subscriber lines, and replacing network elements as they depreciate” (p. 506) are complex and that the efficiency of market governance is likely to be low. We analyze market-related transaction costs in detail based on the three major drivers for transaction costs.

First, consider the frequency of transaction. Net-work operators communicate on a daily basis with their external services partner about technical issues. However, they do not change their service supplier frequently but sign contracts for three to five years, avoiding high costs due to on-going searching and negotiating.

Second, we assess asset specificity of network operation services for a network operator. These assets do not have to be of a physical nature (Klein et al. 1978) [17] and can be interpreted as the knowledge and expertise employees of an external supplier have developed. As mentioned earlier, all major network equipment vendors have the ability to manage not only their own equipment, but also infrastructure initially built by a competitor. Both the interfaces between billing systems or customer management databases and the network infrastructure have been standardized since the launch of 2G mobile. Hence, operators can easily switch suppliers, if they need to.

Third, Environmental uncertainty primarily refers to the inability to predict market demand (McNally and Griffin 2004) [18], which is constantly “shifting and evolving” in the Telecommunications industry (Crandall et al.2009) [16]. Despite this, mobile network operators cannot adapt their physical network quickly to demand fluctuations.

In summary, from a TCE perspective it is important to take into consideration the cost of doing the service. Comparing the internal Cost with the outsourcing costs but taking into consideration the RBV effect. Also, the risk of not being able to get the internal resources back again once we decide to go for outsourcing should be considered.

As well as the service performance comparison (in our case the network performance comparison) into consideration, which will be highlighted in the next section through the Agency theory.

B. Resource Based Review (RBV)

The Resource Based View (RBV) theory posits that firms create sustained competitive advantage with re-sources that are rare, valuable, imperfectly imitable and not substitutable (Barney 1991) [19]. Firms as constructs of human interaction tend to develop their own language for codifying knowledge and their own routines to enhance internal processes. If an activity is highly specific to a company, it is embedded in the company’s language and routines. Employees are then familiar with this “common organization communication code" (Montverde 1995) [20]. Thus, activities can be governed more efficiently within the firm. RBV then does not predict how efficient an external purchase can be, it rather points out that the more firm-specific an activity/resource is, "the greater use it makes of firm-specific language and routines, and hence the more efficient is internal governance" (Poppo and Zenger 1998, p. 858) [12].

From there, It was taken into consideration the importance of the effect of the knowledge/Experience of the firm's employees into its performance, and hence the outsourcing decision.

C. Agency Theory

Agency Theory has a long tradition in analyzing situations when parties cooperate through the division of labor (Eisenhardt 1989) [21]. More precisely, it examines situations where a principal delegates work to an agent. The focal point of analysis is how to align the interests of the agent in an efficient and cost-effective way with those of the principal.

If an agent's performance can be measured adequately, market prices provide the most effective incentives for the agent to act in accordance with the principal's interests (Poppo and Zenger 1998) [12].

If the performance of an agent, however, is difficult to measure, market contracts might be less efficient than internalizing the principal-agent relationship (Barzel 1989, p. 76) [22]. Within an organization, principals can suppress opportunistic behavior of an agent by "behavioral monitoring" (Poppo and Zenger 1998, p. 859) [14] and the use of authority instead of incentives. In market transactions, such instruments are not available.

We now question if the performance of external network operation services can be measured accurate-ly. If all functions related to operation services are outsourced, the focal variable is the overall quality and reliability of the network, which is crucial for the success of an operator. In practice, network operators include key performance indicators, audits and service benchmarks in their contracts with external suppliers and measure network quality via overall network coverage and the number of breakdowns (Friedrich et al. 2009, p. 14) [23].

Agency theory provides a coherent explanation for the importance of the service delivered (in this case the network Key Performance/Quality Indicators) to be taken into consideration as well as the costs and the skills in the outsourcing strategy decision.

III. INTEGRATED FRAMEWORK

By addressing the application of the ideas extracted from TCE, RBV and Agency theories in an integrative framework; it will be possible to understand if it is beneficial for service providers to outsource activities to internationally-based managed service providers or not. Specifically, the author applies RBV to address the questions related to the strategic importance of those activities, assessing whether they are core competences of the firms or not. By contrast, TCE will assist in assessing whether economic advantages are actually achievable by outsourcing activities. Finally, Agency theory will be used to assess the quality measure.

IV. MODEL BUILDING

Epistemologically the research uses a qualitative paradigm, as the objective is to "explore" how the out-sourcing affects the mobile operators' profitability. The author is trying to examine the current change in "outsourcing phenomena" that has arisen in the tele-communication field. The methodology chosen is that of System Dynamics which was developed by Forrester at MIT in the 1950's

The stocks and flows constituting each loop in the proposed Causal Loop Diagram (CLD) have their theoretical underpinning tied to one of the three afore-mentioned theories

The CLD, shown in figure 1, encapsulates the basic idea of this research. The aim is to give decision sup-port for the executives and managements of Telecommunication Mobile operator whether to outsource or not their network activities.

Originally, the idea was to compare the Profits (Revenues-Costs) of those activities when handled in house versus the Profits when they are outsourced. The author soon realized that other elements could affect the customer satisfaction such as the employees' experience/performance and the network. The same could be said for the revenues, as there are a many factors that could impact the revenues such as the sales force and the competition.

After debate with the supervisors and executives in the industry and based on the long experience of the author in the Mobile Telecommunication industry; it was decided to focus mainly on the Network KPIs impact and the sourcing costs.

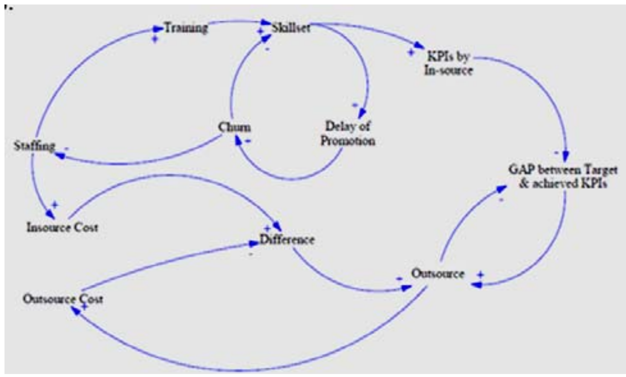


Figure 1. Causal Loop Diagram

The purpose of this model is to help in the decision making of insourcing or outsourcing the engineering services of a given project / rollout based on the following parameters;

1) *Availability of the qualified in-house resources.*
2) *Insourcing cost.*
3) *Out-sourcing cost.*
4) *Best Competitor KPIs.*
5) *Vendor KPIs.*

V. ASSESSEMNT OF BENIFITS

The focus in the upcoming sections is how to determine the availability of the qualified in-house resources and the insourcing costs, then how to build on this to take into account the effect of the Key Performance Indicators (KPIs) and the outsourcing cost.

From a talent perspective, the more platforms an employee knows and understands, the more valuable to the operator he/she is. We use the number of plat-forms that an employee knows as a proxy for their importance to the firm. In order to simulate the avail-ability of in-house resources and their movements (promotions, churn) inside a given organization, the following assumptions is made to be able to quantize the process:

1. The promotion of an employee from a level to another depends only on the employees' knowledge of a specific number of platforms and the availability of open positions in that level.
2. The platform could be the products of a specific OEM or Vendor.
3. The knowledge of a given employee is measured solely by the number of training hours received.

Training Hours_Threshold-1* & *Training Hours_ Threshold-2, are two data inputs which are specific to the company. If the training hours obtained by a given employee are more than ***Training Hours_Threshold-1*** and less than ***Training Hours_Threshold-2*** then this employee knows 2 platforms and if exceeded ***Training Hours_ Threshold-2*** then that employee knows 3 platforms. Assuming ***Training Hours_Threshold-1= 200*** and ***Training Hours_Threshold-2 = 500***, the following platform knowledge will be determined (Table I).

TABLE I. EXAMPLE OF THE PLATFORM KNOWLEDGE DETERMINATION

Employee ID	***Initial Training Hours***	***Platforms Knowledge***
1	550	3
2	230	2
3	220	2
4	220	2
5	100	1
6	90	1
7	80	1
8	70	1
9	100	1
10	100	1

Based on the above criteria, the Employees Experience loop is built.

An initial state is fed into the model, which consists of the training hours already received (Initial data) and the planned number of training hours per year based on the employees' experience (imported data). In the initial trials to build the model, "the training hours" were modeled as one variable containing the total number of hours of all the employees but was not satisfactory as it wasn't possible to increase the training hours per year for each employee differently. Modeling both the training hours for each employee and the rate of increase as arrays solved this problem.

Fortunately, this is an extremely powerful feature of Powersim. One array can hold several values, as op-posed to a scalar variable, which holds only a single value. Each array consists of several elements.

By defining a variable as an array, a group of related values may be represented as one variable which in my case is the training hours received by different employees which gives the ability to simulate the real case which is different employees getting different training sessions.

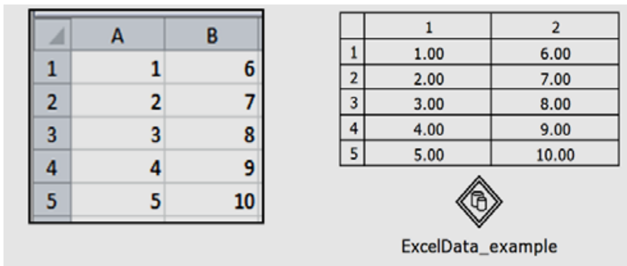
The next challenge was how to import the initial da-ta into the Powersim model, in the beginning a manual method was used to fill the array but it was not accurate or convenient in addition that It leads to a static model i.e. cannot be changed which contradicts with the purpose to have a dynamic & flexible model and also having the data imported manually, limits the number of entries i.e. the employees to be analyzed which will yield to another drawback.

Going through Powersim, a very useful function called XLDATA was found.

The XLDATA function returns the values of an area in an Excel worksheet as a scalar, vector, a two-dimensional array, or a three-dimensional array. XLDATA cannot be used in composite expressions; i.e., it must define a variable completely, and it cannot be used for writing data to Excel.

For example to import the following data range in excel, the XLDATA definition will be XLDATA("C:/../Book1.xlsx", "Sheet1", "R1C1:R5C2") (Table II).

TABLE II. EXCEL DATA SAMPLE



	A	B
1	1	6
2	2	7
3	3	8
4	4	9
5	5	10

	1	2
1	1.00	6.00
2	2.00	7.00
3	3.00	8.00
4	4.00	9.00
5	5.00	10.00

So in order to create an easy to use dynamic model as, XLDATA function was used to create the following 2 arrays; The initial data array that contains the training hours already received for each employee so its dimension is 1 * Number of employees and the imported data array that contains the planned number of training hours per year for each employee so its dimension is 1 * Number of employees.

Through this study, the employees of a given organization will be classified into 3 categories as shown in (Table III).

TABLE III. EMPLOYEES CATEGORIES

Employee Category	*Platforms Knowledge*	*Representation in the array*
Normal	1 platform	1
Experienced	2 platform	2
Rare	3 platform	3

Using Powersim simulation, the number of training hours per employee for a future period of time (Quarters for example) can be estimated based on the set-tings of the simulation (Figure 2).

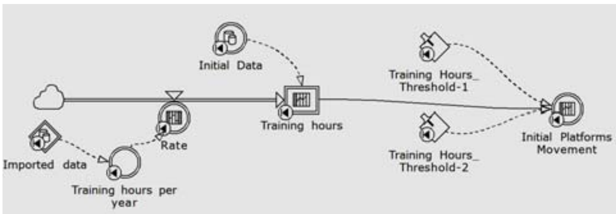


Figure 2. Powersim Simulation

The number of training hours received is simulated with a “level” which acts as a reservoir that keeps the flow (training hours / year) going into it.

The platforms movement is simulated using multiple if condition as shown below;

FOR(i='data range' |

IF('Training hours'[i] >= 'Training Hours_ Threshold-1',

IF ('Training hours'[i] <= 'Training Hours_ Threshold-2',2,3) ,1))

Figure (3) represents the RUN of the above model on 20 employees for 9 consecutive quarters.

Table IV shows the platform movements as an array over years. As an example we can see in year 0 the following array:

{3,3,2,2,2,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1}, which means we have 2 employees as Rare knowing 3 plat-forms, 3 employees as experts knowing 2 platforms and 15 Normal employees knowing only 1 platform.

While in year 5 we have 3 employees as rare and 17 as experts and none normal.

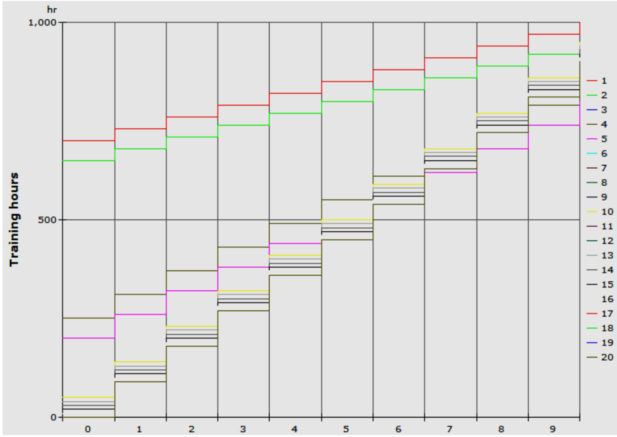


Figure 3. Training Hours’ time graph for 20 employees sample

And the good thing that you can even determine that the 3rd employee is expert and the 4th is rare,

{3,3,2,3,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2}

Using a “for loop”, an “IF condition” decides for each employee the number of platforms he possess based on the threshold training hours then using COUNTEQ function, the number of employees with a given number of platforms is determined (Figure 4)

For example, the array A= {1,1,2,3} COUNTEQ (A,1) will be equal 2,which means the number of repeated an element equal to “1” in the array is 2.

Then to make the study more practical and matching the real case scenario, the churn of employees is taken into consideration and modeled by Exp. leaving per year and rare leaving per year.

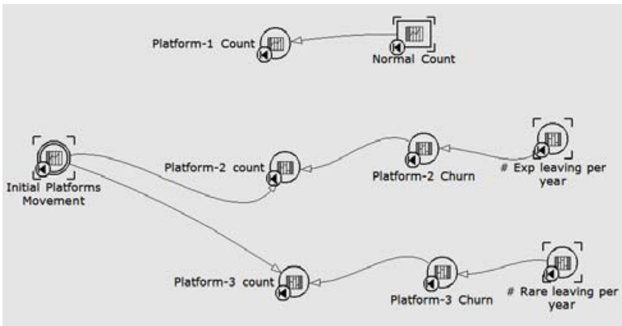


Figure 4. Number of Platform Processed

For a team to achieve certain network KPIs, it should have enough experienced and rare members so an experienced employees target count and rare employees target count are created in the model as user inputs to give the user the ability to adjust the model and the simulations based on the requirements and the experience of the decision maker which in this case will be one of the executives in the MNO.

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As mentioned earlier, the promotion of an employee from a level to another depends on the availability of open position(s) in the higher one so there will be cases when there are employees qualified from a knowledge perspective to be promoted but still no availability/need to promote them so to simulate this case, variables called Experience ready and Rare ready are created as these values will be needed in the decision making of promoting the employees later on.(figure 5).

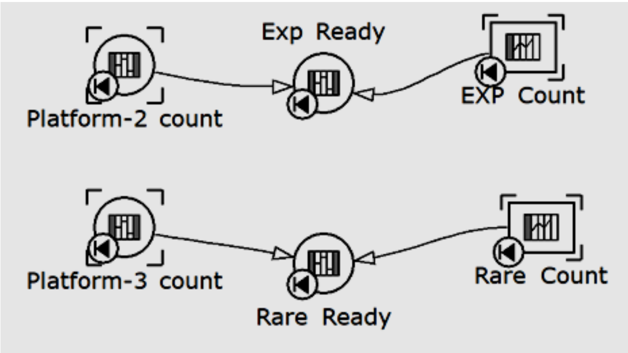

Figure 5. Training hours & platforms knowledge complete model

TABLE IV. EXAMPLE OF PLATFORMS' TIME TABLE FOR 20 EMPLOYEES' ARRAY

year	Initial Platforms Movement
0	{3.00, 3.00, 2.00, 2.00, 2.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00}
1	{3.00, 3.00, 2.00, 2.00, 2.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00}
2	{3.00, 3.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 1.00, 1.00, 1.00, 1.00, 1.00}
3	{3.00, 3.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00}
4	{3.00, 3.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00}
5	{3.00, 3.00, 2.00, 3.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00}
6	{3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00}
7	{3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00}
8	{3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00}
9	{3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00}
10	{3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00}

Experience ready and Rare ready are created, as these values will be needed in the decision making of promoting the employees later on. (Figure 5).

B. Employees' Movement

The second major part of the "employee experience" loop in the model is the employees' movement loop, which builds on the output of the platforms movement loop.

In this loop, the movement of employees between the 3 categories is simulated, taking into account the following parameters;

- The availability of qualified resources to be promoted – Experienced ready & Rare ready.
- The availability of open positions in the high-er categories – Experienced count target & rare count target.
- The churn.

The level of experience required determines the available open positions. For example, in a given project, 15 % of the employees are required to be experienced and 5% must be Rare. Accordingly, based on these count targets, the model will simulate the employees' movement to predict when this employees combination will be available.

If there are no qualified resources available to be promoted, the number of Experienced or Rare employees will be below the target (required) count which will increase the time needed to insource the project on hand and may lead to outsourcing the project if it is time sensitive.

In the initial phase of the model, the employees' counts were modeled as an auxiliary. An auxiliary is used to combine or reformulate information. It has no standard form; it is an algebraic computation of any combination of levels, flow rates, or other auxiliaries i.e. it has no memory.

In this trial, the value of the experienced count for example was calculated at a given instant (for example, a given year) and it will be calculated again based on the equation creating it in the next simulation step which is not adequate for the case at hand where the counts of a given year will depend on the previous one. After studying the different variable types of the Powersim tool, it was found that the best way to model the Normal, Experienced, and Rare employees' counts as "levels".

The concept of levels depends on the fact that every element in feedback loops, and therefore every element in a system, is either a level or a flow. Levels are accumulations and flows represent the changes to these levels. Flows fill up or drain the levels, much as the flow of water into a bathtub fills it, and the drain at the other end (another flow) empties it. This action of flows being accumulated in levels is the cause of all dynamic behaviors in the world.

Therefore, in our case, employees' counts at different categories are levels, the decision of promotions is the flow that fills these levels, and the employees' churn is the flow that drains it.

For example, as shown in the loop below (figure 6), the Fresh to Normal decision is the flow the fills the Normal count level to compensate for the N leaving per year that drains it.

The decision of promotion flow is modeled by an IF condition that includes the parameters mentioned above.

For example to model the Norm to Exp Decision, I used multiple IF condition as follows;

IF ('EXP Count' <'EXP Count Target' AND 'Exp Ready' > 0 <<emp>>,

IF ('Exp Ready'>=('EXP Count Target' -'EXP Count'),'EXP Count Target' -'EXP Count','Exp Ready'),

0 <<emp/year>>)

Using the first condition, the current count of the experienced employees is compared to the target count and also the availability of ready employees to be promoted is checked.

Once the current count is below the target and there is availability of ready employees, the count is in-creased by

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the delta between the target and current counts on condition that this delta count is equal to the ready employees to be promoted.

At each simulation run (for example, on a quarterly basis), the employees' count of a specific category is compared to the target count, if it is less, then a number of employees are promoted to achieve the target count given that they are qualified i.e. know enough platforms.

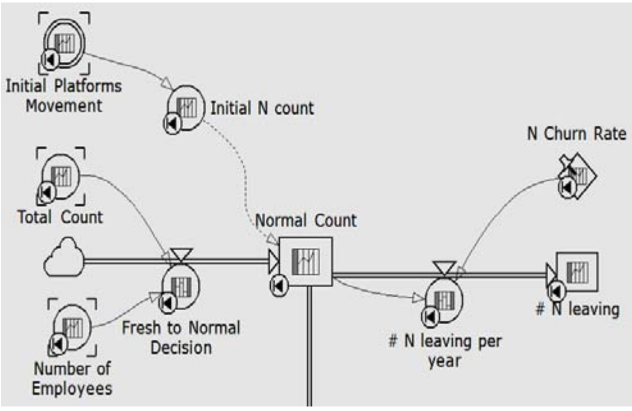

Figure 6

Churn can happen due to different reasons, for example staying in the same position for a long time without a promotion, salary saturation etc.

In this study, the churn flow (rate) is a user input percentage for the sake of simplicity. Another major technique I used to model the employees' movement is the feedback from one variable to another. For example in the loop below, the feedback from the EXP count to the Norm to Exp decision is very important to have accurate results (Figure 7).

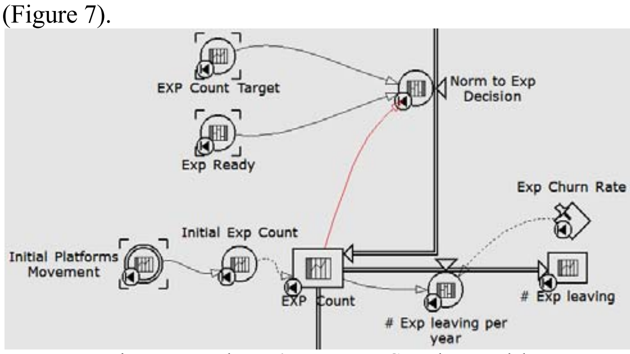

Figure 7. Employees' Movement Complete Model

The charts in (Figure 8) represent the RUN of the above model on 20 employees for 10 years. As an ex-ample, if we look at year 1 we can see: 15 Normal, 3 Experienced and 1 Rare.

By checking the values, we will see that the model is adjusting the counts to match the input target counts, so for example in the above simulation, the target count was 4 for experienced and 3 for rare which are the numbers the model is trying to achieve.

To test the outputs of this loop, input target counts are applied as in (Figure 9). Starting from an initial state of {16, 3, 1} and checking the output of the loop, it is clear that the model managed to achieve the target counts {12, 6, 2} starting the 5th quarter.

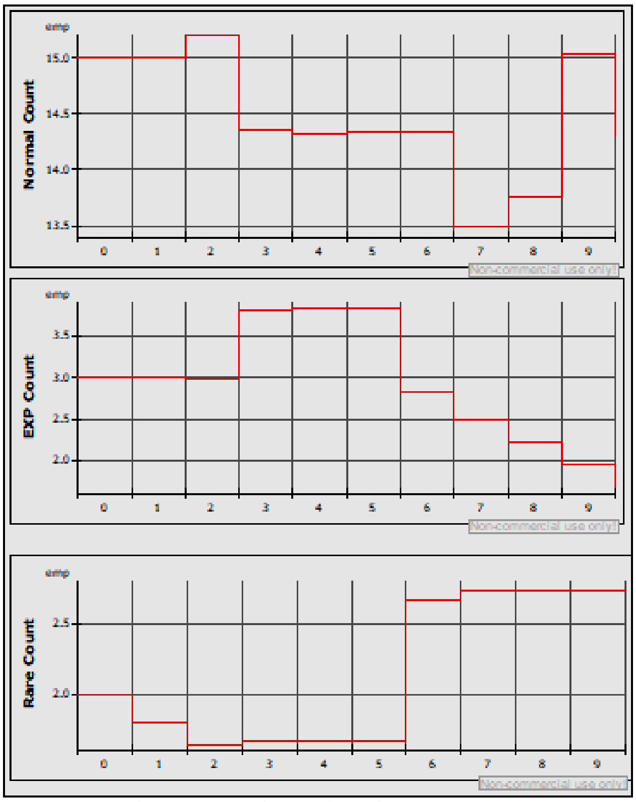

Figure 8. Normal, Experienced & Rare Counts

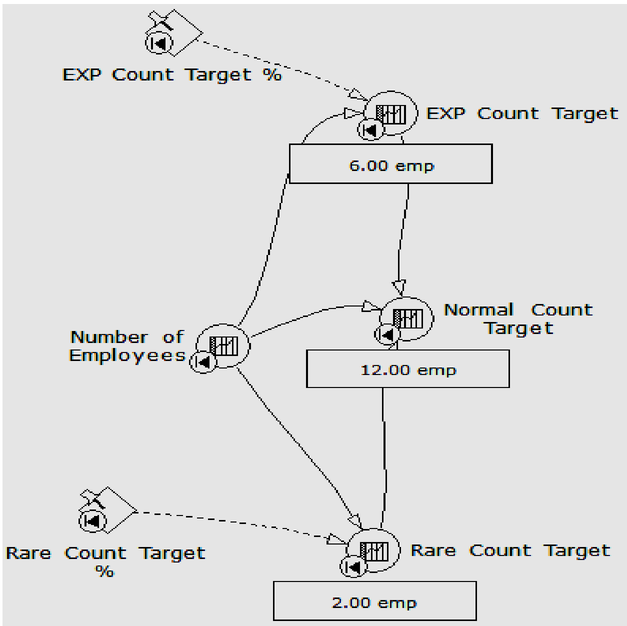

Figure 9. Example of the Loop Output

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TABLE V. EXAMPLE OF LOOP OUTPUT

Year	Normal Count (emp)	EXP Count (emp)	Rare Count (emp)
0	16	3	1
1	16	3	1
2	13	6	1
3	13	6	1
4	13	5	2
5	12	6	2
6	12	6	2
7	12	6	2
8	12	6	2
9	12	6	2
10	12	6	2

Another example to test the outputs of this loop with the following inputs as target counts (Table VI);

Starting from an initial state of {16, 3, 1} and checking the output of the loop, the model is approaching the target count {14, 3, 3} as it achieves {15, 2, 3} starting the 5th quarter.

TABLE VI. EXAMPLE OF LOOP OUTPUT

Year	Normal Count (emp)	EXP Count (emp)	Rare Count (emp)
0	16	3	1
1	16	3	1
2	16	3	1
3	16	3	1
4	16	2	2
5	15	2	3
6	15	2	3
7	15	2	3
8	15	2	3
9	15	2	3
10	15	2	3

C. Insourcing Cost

Given the counts of employees at different categories, the insourcing cost can be estimated.

The following parameters are taken into consideration to estimate the overall cost of insourcing (Figure 10);

1) *Tools for the staff.*
2) *Transportation.*
3) *Training*
4) *Location*
5) *Salaries including annual raise and bonuses.*

Cost of tools, transportation, training and location are modeled as constants that represent information that is not changed by the simulation, but the user through input controls based on the user requirements can change them.

Constants are often used to identify and quantify the boundaries of the model, and to represent decision parameters. They are, as the name implies, constant, and the definition only defines the initial value (the definition is only calculated at the start of the simulation). In addition, it is possible to assign a new value to a constant through input controls, thereby changing the scenario of the model. By creating permanent constants, we can create constants that not only keep their values over one simulation run, but also keep its value between simulation runs. Permanent constants help to create simulations that "remember" the input given by the user. It is useful to create constant variables rather than including literal constants in various variable definitions, this help to clean up the model and visualize parameters that might be decision parameters in the system.

It also helps to gain full effect of Powersim powerful unit detection capabilities. In addition, if it is needed to change units at a later stage; I will only have to do so for a handful of constants rather than going through all the variables of your system to find them.

Cost of salaries is modeled as a level as it represents states in the system that change over time. Levels are variables with memory, and their value is determined by the flows that flow in and out of them.

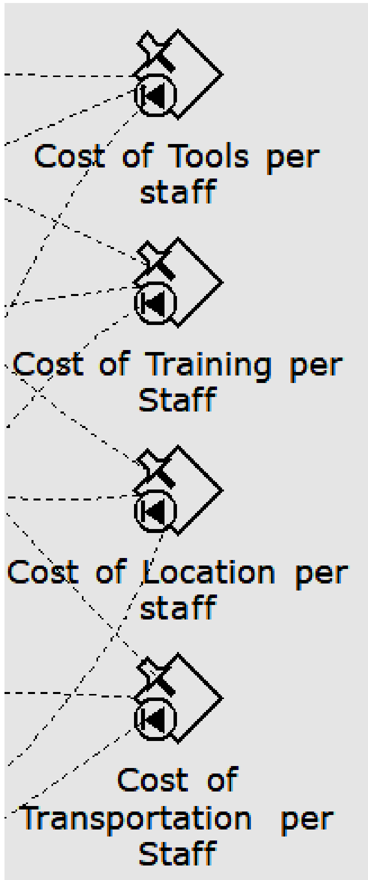

Figure 10. Insourcing Cost parameters

The rate of change of the salary (in-flow) is the annual raise and to take into consideration the salary saturation after a certain number of years, the annual raise of the salaries is only applied for a given number of years only such that the model provides more practical results as shown in the time graph below (Figure 11).

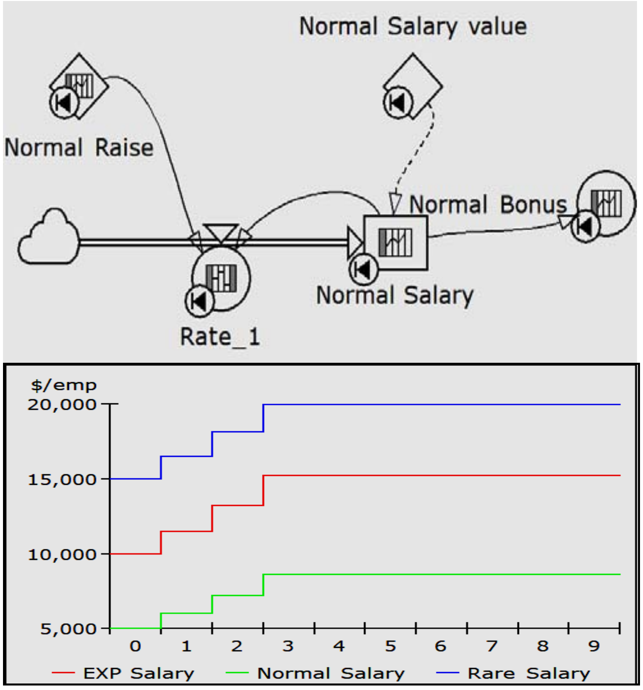

Figure 11. Employees' Salaries Over the Years

As shown above, the salary saturates after year 3, which is one of the main reasons of employees' churn.

TABLE VII. EXAMPLE OF LOOP OUTPUT

year	Insourcing Resource cost	Cost of Normal Staff	Cost of Exp Staff	Cost of Rare Staff
0	1,574,000.00	915,000.00	276,000.00	383,000.00
1	1,652,400.00	975,000.00	303,000.00	374,400.00
2	1,763,669.00	1,060,960.00	331,823.00	370,886.00
3	1,965,398.39	1,085,041.60	468,852.51	411,504.28
4	1,965,743.82	1,082,623.68	473,191.00	409,929.14
5	1,965,674.74	1,083,107.26	472,323.30	410,244.17
6	2,088,551.05	1,083,010.55	349,244.34	656,296.17
7	2,000,915.79	1,020,045.49	308,154.91	672,715.38
8	1,986,556.07	1,040,194.50	275,288.11	671,073.46
9	2,049,244.29	1,136,407.60	241,599.04	671,237.65
10	1,960,663.72	1,081,450.29	207,992.19	671,221.23

VI. CONCLUSION

The introduction discusses an important question that must be answered by mobile operators which is whether outsourcing will bring long-term bene-fits. Currently, such decisions are based solely on the experience and judgement of the managers. This paper has shown that this experience and judgement can be captured and incorporated into computer software i.e. a decision support tool can be built that will greatly assist the making and the justification of the decision.

Using the System Dynamics methodology and the software tool, Powersim, I have constructed a system that predicts and simulates the availability of in-house resources. The tests indicate that the strategy suggested by this tool will be able to achieve prescribed net-work Key performance indicators (KPIs) and it has all the functional ability to relate them to the available experience of the in-house staff.

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