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Chapter 2
Prioritizing the Roles of Control Mechanisms in Digital Platform:
An Analytic Hierarchy Process Approach

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ABSTRACT

Existing literature on control in software development considers only the principal-agency relationship between controller and controlee and this view does not hold true between ecosystems leader and partners, which are independent organizations. This chapter aims to study the critical role played by inter-organizational control mechanisms in the context of mobile platform ecosystems. By utilizing opinions of 38 experts and employing an Analytic Hierarchy Process (AHP) approach, this chapter identifies and ranks the most important roles played by control mechanisms in digital platform. The findings show that ecosystems´ leaders primarily use control to manage or improve its central position in the network to capture a higher share of value of the service. The findings provide further insights on two other roles of control in platform ecosystems: (1) accessing complementary resources and (2) managing interdependency between partners. This chapter contributes to organizational control theory in the context of emerging platform-based ecosystem.

INTRODUCTION

With the advances of feature-rich mobile phones equipped with high computing power and mobile network technology, mobile communication has spread and diffused into our daily lives, both in modern western economies as well as emerging economies. Moreover, Salama and Shawish (2012) argue that developments of digital technologies have increased the possibility of horizontal and vertical integra-

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tion of knowledge, communication and information. Business managers are also aware that the future growth of revenues in the mobile telecommunication industry, rather than by subscriber growth alone, will be driven by innovative mobile value-added services (Gerpott, 2011). A consumer survey (IBM Global Telecommunications Consumer Survey, 2014) shows that in emerging markets, users are planning to spend more on mobile services in the next two to three years, while reducing consumption in many other areas, such as electronics. The same survey also indicates that, at a global level, almost one-third of the users are planning to reduce their usage of voice and text (SMS) services, while increasing their usage of the Internet, mobile applications and over-the-top (OTT) services such as Viber and WhatsApp.

Other than individuals, enterprises from different industries are also transforming their businesses with the help of mobile services to: (i) achieve their business objectives such as differentiation and personalization of customer experience (ii) extend their business to the workforce mobile and customers and (iii) improve operational efficiency as well as customer intimacy (IBM Institute for Business Value, 2012).

The World Bank, International Finance Corporation (IFC) and other international agencies have identified mobile technology as a medium for achieving objectives such as financial inclusion, increase in GDP in developing nations, reduction in financial transaction costs, and bringing more transparency and effectiveness in government spending (World Bank, Information and Communications for Development: Maximizing Mobile, 2012). It is important to mention that three important developments in the realm of business model and technology are responsible for higher adoption and usage of mobile services by individuals as well as organizations. Firstly, extensive improvement and rapid enhancements in features of user devices, and an associated reduction in costs (Becker et al., 2012). Secondly, the technological evolution of mobile networks, which makes it easier to carry large volumes of digital traffic (Dekleva et al., 2007). Lastly, the emergence of new business models (i.e. business model innovation) for mobile services development in the form of mobile ecosystems and platforms (Basole & Karla, 2011; Basole & Rouse, 2008; Bouwman et al., 2008; Nikou, et al., 2014; Tiwana et al., 2010). In mobile ecosystems, multiple partners work together and combine their resources and capabilities to ensure (higher number of) innovations in a shorter time-span. From an academic point of view, these trends lead to question about how business models and constituting mobile ecosystems are being formed and evolved over the time. Other than the mobile domain perspectives, the research related to platform and ecosystems is also gaining momentum due to two other reasons. The first one, is the digital ecosystems which has emerged as the most dynamic and exciting source of innovation (Eaton et al., 2011). The other significant reason is the competition and innovation development in business which has shifted from the preview of standalone enterprises towards platform-based ecosystems (Tiwana et al., 2010; Qiu et al., 2017). Specific to mobile device industry, in 2007 and before the advent of platform, five independent enterprises (Nokia, Samsung, Motorola, Sony Ericsson and LG) captured 90% of industry's profit. However, with the successful introduction of Apple's platform and associated ecosystems, Apple could capture 92% of global profit in 2015, leaving little to benefit from for other players in the ecosystems (Van Alstyne et al., 2016).

Literature informs us about the sheer volume of prior studies on different aspects of the business model related to e.g. mobile ecosystems (Basole & Karla 2011; Zhang & Liang, 2011), governance of mobile value-network (De Reuver, 2011, De Reuver & Bouwman, 2012) and platform governance and architecture (Tiwana et al., 2010, Tiwana, 2015). Ballon (2009) indicated that control strategy is a crucial part of the business model in mobile ecosystems. Control strategies and control points make the attainment of goals in a multi-organizations alliance more predictable, influences undesirable behavior of partners, and reduces the chances of unpleasant surprises or unexpected outcomes (Das, 1993; Merchant, 1985). The absence of a clear control portfolio makes control strategies inefficient and increases the cost of control deployment and monitoring (Herath, 2007; Simons, 1995). Similarly, too many controls or ill-defined controls can also hinder innovation in the mobile ecosystems, which is the primary motivation for creating an ecosystem. However, in the context of mobile platform ecosystems, the usage of control mechanisms and the critical roles that they play need further investigations.

The usage of control mechanisms in the Software industry can be a good starting point. In the case of control research in outsourced and offshore software projects, researchers are focused on the design, evolution and performance of control portfolios (Choudhury & Sabherwal, 2003; Rustagi et al., 2008; Srivastava & Teo, 2012; Tiwana & Keil, 2007; Tiwana & Keil, 2009). However, few recent studies have examined control in the context of platforms and the ecosystem setting. For example, Ghazawneh and Henfridsson (2013) have proposed to use boundary resources to control platforms and their ecosystems in the context of third-party software development. The authors have found that boundary resources can be used to resolve the paradox of simultaneous control and generativity. Eaton et al. (2015) worked further on the boundary resource construct and proposed a process model that explain the emergence and evolution of boundary resources. Goldbach and Kemper (2014) analyzed the different effects of the control modes in software-based platforms and show that how control modes influence developers' intentions to stay with a particular platform.

In the context of software development, different aspects of control are extensively researched. Nevertheless, there are significant differences between the context of software development and platform-based ecosystems. Software development can be investigated through the prism of agency theory (Jensen & Meckling, 1976), where the principal delegates tasks to the agent for fulfilment. The agency theory deals with how to deal with incongruent goals between principal and agents, and to reduce chances of the agent's opportunistic behavior. The relationship between platform owners and other ecosystem partners cannot be classified as a principal–agent relationship, as partners are not hired by the platform owner to execute a specific task (Goldbach & Kemper, 2014; Tiwana et al., 2010). The relationship here is less hierarchical. Unlike in the software development scenario, ecosystem leaders cannot dip into the principal–agent relationship to demonstrate their influence or authority over others. So, one cannot assume that controls are primarily used to mitigate agency hazards in platform ecosystem. Moreover, though behavioral and outcome controls are extensively researched in the IS (Information Systems) domain, input control has been ignored and not adequately researched (Tiwana et al., 2010). Input control is widely used in all major platform ecosystems (Manner et al., 2012; Tiwana et al., 2010, Tiwana, 2015).

This chapter aims to address the knowledge gaps related to control mechanisms in platform ecosystems, especially in the context of mobile service development. The authors primarily aim to find out why ecosystems leaders use control in ecosystems in spite of its additional overhead for monitoring and its possible negative impact on innovation. At the operational level, the research further identifies the most important roles of control mechanisms and their relative priorities in mobile platform ecosystems formed for multi-organizational collaboration. To do so, an Analytic Hierarchy Process (hereinafter, AHP) developed by Saaty, 1980 is employed. AHP is a multi-criteria decision-making approach and preference elicitation method to investigate preference of managers (Adler & Borys, 1996; Cardinal, 2001; Johnson, 2011; Samuelson, 1938).

This chapter is structured as follows. Section 2 discusses the underlying theoretical foundation and focuses on ecosystems and organizational control. Section 3 discusses an AHP based research approach and illustrates the conceptual research model. Section 4 describes the result of the empirical investigation. Section 5 elaborates and discusses the results and provides the theoretical and practical contributions. Section 6 provides conclusion, discusses the limitations and provides suggestions for further research.

BACKGROUND

In following subsections, the authors discuss the business ecosystems and elaborate on the control mechanism and its several types and modes.

Business Ecosystems

Moore (1993, 1996) introduced the concept of a business ecosystem as a network of organizations collaborating and competing around a technology. The concept, taken from an ecological metaphor, assumes that firms are part of a larger ecosystem with interdependency and interconnectedness (Autio & Thomas, 2014). Business ecosystem concepts allow organizations to be positioned as part of a larger community, instead of limiting partnerships within their supply chain (Rong et al., 2013). Iansiti and Levien (2004c) specified that the core technology in the business ecosystem can either be in the mode of a platform, service or any tool required and valued by other members. The members of the ecosystem tend to align themselves with the direction of a central leader who plays a critical role in developing and nurturing the ecosystem. Iansiti and Levien (2004a, 2004b) argue that in an ecosystem, the participant firms, particularly the leader can play different roles with an eye on the improvement of their performance. It is also possible for a member to fulfil multiple roles in one ecosystem or play different roles in different ecosystems. Some researchers have identified five important roles that members of an ecosystem can play: (1) keystone, (2) landlord, (3) dominator and (4) niche (Iansiti & Levien, 2004a, 2004b; Zhang & Liang, 2011). The keystone players create and control key ecosystem hubs, core technology and platform. They encourage other players to join and innovate within the ecosystem and are more open to share values with other members of the ecosystem. The second and third roles (i.e. landlords and dominator) control key ecosystem hubs, platform or technology and capture maximum value for themselves. By capturing too much value from others for themselves and discouraging innovation from other players, landlords might damage the ecosystem. On the dangers posed by dominators, Iansiti and Levien (2002) argue that they reduce diversity in ecosystem composition and innovation, and also eliminate competition. As a result, the health of the business ecosystem is negatively impacted. Based on the strategic choices or preferences of the ecosystem leader for a particular role (keystone, dominator or landlord), the role of control mechanisms would also vary in a particular setting. Other than the focal organizations, most other firms or partners in organizations can occupy the ‘niche’ role. They are responsible for most of the actual work and innovation; hence critical to the growth and diversity of an ecosystems (Iansiti & Levien, 2002).

Organizational Control

Ouchi (1997, 1979) has initially developed the dominant model of organizational control theory. However, many researchers (Choudhury & Sabherwal, 2003; Eisenhardt, 1985; Govindarajan & Fisher, 1990; Snell, 1992) have further contributed in expanding our understanding. In organizational literature, control is viewed from different theoretical perspectives, such as cybernetics/process, power/authority, cultural (Das, 1993), and principal–agent relationships (Kirsch, 1997). In an ecosystem or platform setting, controls are also used by dominant partners to keep their predominance in the network by controlling access to scarce resources and assets (Ballon, 2009). Synthesizing multiple perspectives, we have defined ‘controls’ as the mechanisms utilized by ecosystem leaders to create conditions that motivate and influence other participating organizations to achieve a desirable outcome and, in the process, reduce the risks, uncertainties and costs involved in procuring resources for dominant organizations.

Control Types or Modes

According to organizational control literature, there are three types of formal controls: behavioral, outcome and input control (Eisenhardt, 1985; Johnson, 2011; Kirsch, 1996, 1997; Kirsch et al., 2002; Ouchi, 1979; Snell, 1992). Though, few researchers have also mentioned some other specific types of informal and formal control, the above subdivision provides a parsimonious framework and other specific manifestations of control like social control can be explained as specific manifestation of one of the three control types (Johnson, 2011). It is recommended to use the behavioral controls when desirable behavior necessary for execution of a task is identified and the required behavior can be observed (Govindarajan & Fisher, 1990). In mobile ecosystems, behavioral control would for instance concern imposing procedures on how applications should be developed and offered to the end-users. In an outcome control scenario, the focus is limited exclusively to understanding, evaluating and monitoring the final results. Network partners are free to decide how they will achieve the desired outcome. In mobile ecosystems, the most important outcome controls are division of roles and differentiated revenue share agreement with partners. The third type of control (i.e., input control) is used to acquire specific skills and experiences. In platform ecosystems, input control is for instance related to onboarding criteria for partners and grading them in multiple tiers. Focal players select the partners and admit to the ecosystem because they can provide the desired resources (Cardinal, 2001; Snell, 1992). The input control is also used for admission control to reduce congestion and overcrowding as well as reduce intra-platform competition (Kim, 2017; Tiwana, 2015). In a recent research; Wesel et al. (2015) found that relinquishing input control increased diversity of the platform output, but at the same time endangered platform's reputation by increasing variance in quality.

Ouchi (1979) suggested, starting from a contingency view, that a specific mode of control can be related to a specific context, and a specific type of control mechanism is related to a specific situation. However, some studies showed that a focus on multiple control modes (i.e., using a mix of control modes within a portfolio) was more effective and did lead to achievement of desired objectives (Jaworski et al., 1993; Harmancioglu, 2009). As a result, instead of a single control, it is proposed that a portfolio of different combinations of control modes should be used (Kim 1984; Kirsch 1997). Although, it might be assumed that platform leaders opt for one specific control mechanism, the authors recommend to create and deploy an appropriate control portfolio, consisting of different amount of above three control types.

Role of Control

Next, we consolidate the key functions of control portfolio based on existing literatures of organizational control and mobile ecosystems and platforms. From the organization control literature, the primary functions of control are to manage or mitigate two important risks, (a) relational risk and (b) performance risk (Das and Teng, 2001). While the mobile ecosystems literature proposes that platform ecosystems leader uses control to (a) manage interdependencies between partners (b) acquire relevant complementary resources and (c) manage its central position in platform ecosystem (Mukhopadhyay et al., 2015, 2016a, 2016b; Tiwana et al., 2010). It is also important for the leader of the ecosystems, to decide upon the priorities among three high level objectives. These high-level objectives correspond with a number of second level objectives. Three high-level attributes and their corresponding second level alternatives are discussed below as they are operationalized in the context of mobile ecosystems.

Manage Interdependencies Between Partners

In an inter-firm relationship, strategic objectives of different ecosystem participants may be different and change over time. So, the ecosystem leaders need to ensure that different partners collaborate to achieve the shared vision and also need to manage conflicts between partners. As in an ecosystem, the partners compete and collaborate; the researchers also need to look into intra-platform competition and its impact on the performance (Tiwana, 2015). Conflicting interest, if not managed properly can block collective innovation process (Valkokari et al., 2017), the primary motivation for forming the network.

Technically, the platforms driving the ecosystem can be conceptualized as a set of multiple discrete components owned by different partners and interacting through standardized interfaces (Baldwin and Clark 2000; Gawer, 2014). Once the overall vision, components and interfaces are in place, each of the partners need to focus on their development, customization of the work independent of other component owners, but within the overall rules for the architectural design (Tiwana et al., 2010). To deliver service combining the outcome of multiple partners, the ecosystem leaders need to manage interdependencies and interaction between the partners. The role of coordination is one of the primary roles of the control in an ecosystem (Tiwana et al., 2010). The literature suggests that ecosystems leaders manage interdependency between multiple partners through three sub-activities, (a) defining roles of each partner and of the components they provide, (b) agreement on broad design guidelines and on a shared product vision to drive customization and (c) sharing of interfaces, so necessary flow of information can happen between components. Given the above context, control objective to manage interdependencies is positioned as one of the main attributes for designing portfolio of control (level 1) as will be used in our AHP research model. Table 1 show this attribute and its three (second level) alternatives (i.e. role, interface and customization).

Acquire Complementary Resources

The core reason to collaborate with others is to access resources on which a focal actor depends (Pfeffer and Salancik, 1978). Developing and offering innovative services is a complex activity that requires a broad set of diversified resources and capabilities (De Reuver, 2011; Peppard and Rylander 2006). Besides particular to mobile internet services, there is a plethora of mobile value-added services available in the telecommunications market, but only few of them have been broadly adopted or generate significant revenues (Bouwman et al., 2012; Constantiou et al., 2006; Nikou et al., 2011a, b). Technological issues

Table 1. Manage interdependencies and its alternatives

Manage interdependencies	The mechanisms for managing the interaction and resource related dependencies among partners as well as mechanism for conflict resolution
Role	Mechanisms to define and enforcing specific role for each partner for this service throughout the lifecycle of the services. Each partner is asked to focus on different components of the technical platform, which has been possible due to technical architecture of the platform supporting an ecosystem
Interface	Mechanisms to ensure data and information flow between components through agreed interfaces. This is important, because as per the agreed roles, each of the partner focuses on a particular component of the ecosystems and they depend on interfaces for sharing of data and information and abstracting complexities of their components.
Customization	Mechanism to define customization requirement for partners keeping in mind the overall solution requirement. The lead players need to articulate the changes required from each partner’s standard offering to create an integrated service offering consolidating different partner’s output

related to network and customer devices as well as poorly understood customer preferences prevent broad adoption of mobile services. This results in a higher percentage of failures of mobile value-added services (MAVSs). As a result, multiple organizations need to work together in a complex inter-organizational network to develop and commercialize these services (de Reuver and Bouwman, 2012) both for rapid innovation and risk sharing. From the above discussion, the key factors that pushes for organizations to enter into inter-organizational exchange relationships are access to information, expertise, large number of customer and new lucrative markets (Kim et al., 2016) as well as sharing of risks.

Thus, the ability to access complementary resources that are required for the service offering is a core performance criterion. To achieve it, the leaders of the ecosystem take advantage of the architecture of platform and exploit economies of scale by attracting complementors (Gawer, 2014). In a research involving multiple case studies, Mukhopadhyay et al. (2015) found that the ecosystems leaders possess and control critical resources required for service development and use input control to acquire other resources necessary for service development from partners with appropriate capability and attitude. As, there exist major technological and project management risks for integrating diverse partners, the leader of the ecosystems prefers to collaborate with proven and reliable partners who have worked with them before and have demonstrated to be able to realize the expected results. Gulati (1999) argues that a current or prior partner becomes an attractive option for collaboration and partnership due to its demonstrated capabilities and trustworthiness. Similarly, a partner already pre-integrated with the IT and network side of platforms reduces integration complexity between multiple systems as well as squeezes the time required for systems integration (Ballon, 2007). Based on the above discussion, the authors suggest three (second level) alternatives (i.e. partner capability, partner experience and integrated partner) for the attribute "acquire complementary resources" (see Table 2).

Manage Its Central Position in Platform Ecosystem

As the lead players invest significantly in the conceptualization, development and commercialization of a platform, it is important for them to control, upgrade and manage their central position in the ecosystem. Central position allows them to get adequate pay-off from their returns as well as say in the key decisions related to the platform. The fact that out of 40-50 mobile platforms, 97% of the total mobile market is held by only seven platforms (Basole & Karla, 2011) illustrate a high risk associated with this business. Besides, in an ecosystem, relationships between multiple organizations are not static and evolves amidst collaboration, competition and conflict. In this process, relative position of actors gets altered (Pellikka & Ali-Vehmas, 2016; Valkokari et al., 2017). The above discussion signifies the importance of securing and defending the central position of the ecosystem leader.

Table 2. Acquire complimentary resources and its alternatives

Acquire complimentary resources	**Mechanisms to acquire resources required for service development but not owned by dominant player**
Partner Capability	Mechanisms to identify and acquire partners with required capability and attitude. It involves bringing partners having specific capability required for that particular service
Partner Experience	Mechanisms to acquire partners with prior experience of working together with the leader. The lead partner prefers to work with partners, with whom they have worked successfully in the past
Integrated Partner	Mechanism to acquire partners who are already integrated with lead partner's IT/Network systems

Central position allows them to get the possibility to generate appropriate economic rent or appropriate return for the risky, innovative initiatives as well as say in the major decisions related to the platform. The mobile value-net and ecosystem literature provides examples of multiple instances, where the leader uses the control portfolio to manage their position. Ballon and Walravens (2008) introduced the concept that ecosystem leaders intend to occupy critical value-adding roles or gatekeeper roles within the ecosystem. They discussed about the four structural or value-adding roles in the context of mobile service delivery, but the most important roles are related to controlling access to users and roles related to charging and billing of services to end users. Through occupying the above two roles, the lead actors control complete access to customers and the network. However, the question is which partner assumes the direct relationship with customers is very important aspect of business model design (Ballon, 2007). Similarly, the lead partner also wants to establish complete control over the services that would be served by the platform. The complete control allows the lead partner to say no to other partners (if required) when they want to introduce new innovations or new features through the platform (Herzhoff, 2011; Herzhoff et al., 2010). Control over the product allows the ecosystem leader complete authority to decide and launch the product and the variants that are a strategic fit for it and the overall ecosystem, instead of allowing all types of services.

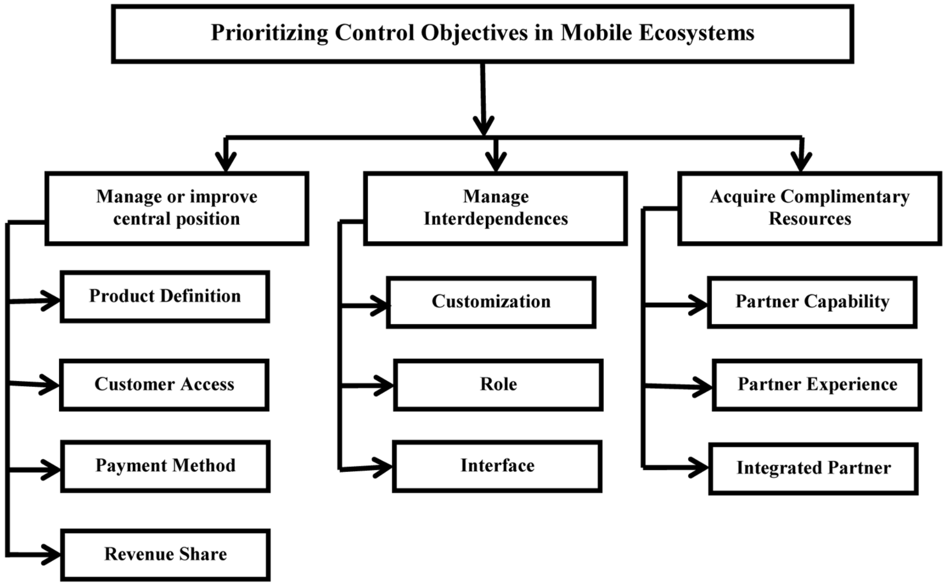
The third method for managing or improving its central position is more direct. It is done by drafting revenue sharing arrangement in a way that is beneficial for the leaders of the ecosystems. The existing literature supports that appropriate revenue sharing models are important for the success of business models (Lindmark et al., 2004). In their case studies, Mukhopadhyay et al. (2015) found that ecosystems leaders actively manage the revenue settlement process between partners and received higher revenue share compared to other partners. So, control is used in a number of ways to safeguard customer relationship and ensure higher value share for the ecosystem leaders.

As a result, the authors consider the managing or improving the central position as the third objective or (first level) attribute for portfolio of control and suggest the following four (second level) alternatives (control over product definition, customer access, payment method and revenue sharing) for more information see Table 3. Based on the above discussion on attributes and alternatives for portfolios of control, the following research model is designed (see Figure 1). The model consists of three objectives of control portfolios, hereinafter referred to as the first level or attributes and the second levels, hereinafter referred to as alternatives.

Table 3. Managing central position and its alternatives

Manage its central position	How value derived from the user by selling the service is distributed among its partners
Product Definition	The ability to define products, their variants and their pricing
Customer Access	The ability to own the customer and restrict access to them by other partners
Payment Method	The ability to use one's own payment/ billing method or define preferred payment method for end users
Revenue Share	The ability to receive higher revenue share compared to other partners

Figure 1. The research model



RESEARCH METHODOLOGY

The authors use an Analytic Hierarchy Process (AHP) approach to identify and priorities the most important attributes and alternatives of portfolios of control used in the platform ecosystems. Analytic Hierarchy Process (Saaty, 1977, 1980) is a structured technique for organizing complex decisions and is an appropriate method to be used when the objective is to elicit the preference of the individuals or a group of people (c.f. Nikou and Mezei, 2013). When an AHP approach is used in a research, several steps need to be consecutively performed.

1. In the first step, the problem is decomposed into sub-problems. The problem at hand in this chapter is to prioritize the control objectives in mobile value-added service ecosystems and will be placed in the highest level of the hierarchical structure, (see Figure 1).
2. In the hierarchical model, the dependencies are only among elements in the same cluster and the impact is only towards the top of the constructed structure. For example, the main goal formulated for this research, i.e. prioritizing the most important factor of designing control portfolio can be solved through investigation of the mutual independent concepts on the top-level or the attributes, (1) manage its central position in the ecosystem, (2) manage interdependencies and (3) acquire complimentary resources. Then, these attributes can be decomposed individually in the form of the second levels (alternatives) in the hierarchy structure. For instance, manage or improve central position can be decomposed to (1) product definition, (2) customer access, (3) payment method and (4) the revenue share. It is assumed that the components of different clusters on the second level are independent from each other and there is no interaction and dependencies between, e.g. customer access (from manage or improve central position cluster) and e.g. role (from manage in-

terdependencies cluster). An AHP hierarchy tree can have as many levels as needed. For example, in the proposed research model there are two levels (1) attributes (2) alternatives.

3. In the third step and making use of the pairwise comparisons, one can obtain the relative importance of each level in the hierarchy tree. It is important to mention that the entire set of the comparisons must be done within the sub-problem and with respect to the parent. For example, payment method is compared with revenue share with respect to its parent that is manage or improve central position in the AHP model. By combining the entire comparisons into a comparison matrix, one can obtain the weights for each criterion (attribute).
4. One of the important step in executing research utilizing an AHP approach is the evaluation of the consistency in judgements. Different tools and software have been dinged and developed to perform this task. Of those available options, "Expert Choice" is one of the widely used applications for analyzing the data and measuring the consistency ratio. A simpler and less costly approach, which is used in this research, is making use of a Microsoft Excel Spreadsheet with an AHP Excel Add-in. Table 4 shows the verbal scale which is used to ease the task of comparison and reduce the respondents' fatigue. For example, if a subject wants to assign a very strong importance to payment method over revenue share, she should use seven.
5. Synthesis of the analyses results to obtain the overall ranking (final ranking) is the last step is performing an AHP research. A matrix of judgements can be constructed by making use of the pairwise comparisons performed during the data collection process.

It is a common consensus that the basic assumption of AHP is the reciprocity of the pairwise comparisons:

$$a_{ij} = {}^{1}\!/_{a_{ji}}$$

i.e. the judgement 5 for the pair (manage or improve central position and acquire complementary resources) implies that the value in the matrix for the pair (manage or improve central position and acquire complementary resources) is 1/5.

Table 4. The linguistic description of the numerical scale in AHP

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities considered equally important
3	Moderate importance of one over another	One activity is marginally favored over another
5	Essential or strong importance	One activity is strongly favored over another
7	Very strong importance	One activity is very strongly favored and its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order
2, 4, 6, 8		Intermediate values between two adjacent judgments

$$A = \begin{pmatrix} a_{11} & a_{12} & .. & .. & a_{1n} \\ 1/a_{12} & a_{22} & & & a_{2n} \\ .. & & & .. & .. \\ .. & & & .. & .. \\ 1/a_{1n} & 1/a_{2n} & .. & .. & a_{nn} \end{pmatrix}$$

Then in the next step, these judgements will be used in order to determine the vector of local priorities of the factors in a sub-problem. This task is performed with respect to the parent of each sub-problem. The notion of $\underline{w} = (w_1, \ldots, wn)$ can be used for this vector. Saaty's theory considers that every element in the matrix is an estimation of the ratio of the corresponding local weights (Saaty, 1980), showing in the following equation:

$$a_{ij} \approx w_i / w_j$$

The consistency of the decision maker is an important factor and one can expect that the decision maker is consistent throughout her judgements. For instance, if the manage or improve central position is preferred over the manage interdependencies by 2 times and the same person prefers factor manage interdependencies over acquire complimentary resources by 3 times then manage central position should be naturally preferred over acquire complimentary resources by 2*3=6 times (i.e., for every i, j, k, the elements of the matrix satisfy the equation:

$$a_{ij} a_{jk} = a_{ik}.$$

According to the matrix of the pairwise comparisons, the weight vector can be calculated in different ways, such using the theory of eigenvectors and eigenvalues. The optimal consistency would be when the weight vector is the eigenvector of *A* corresponding to the maximal eigenvalue *n*. We can calculate this by solving the matrix equation in the following:

$$A\underline{w} = n\underline{w}$$

If the matrix of judgements is not consistent, the maximal eigenvalue, λmax will be different from *n*. Thus, the solution of the equation below provides a rough estimation of the weight vector and its reliability can then be measured by obtaining the value of consistency ratio (CR).

$$A\underline{w} = \lambda_{\max} \underline{w}$$

The consistency ratio assesses how consistent the comparisons are relative to large number of purely random judgements (Saaty, 1977). If the value of consistency ratio is equal to zero, one can assume a perfect consistent judgment and if the value is equal to one, then the judgment is inconsistent and it can be assumed that the judgments were made on the random basis and the subject has performed the pairwise comparison in a random fashion. But, nevertheless, the consistency ratio value between zero and one is considered acceptable. The consistency ratio is preferred to be below (0.10). Synthesising of the local weight to find the global weight of the attributes is the final step in the data analysis.

To compute the global weight, one can multiply the local priorities by the priority of the antecedent elements. In this way, the numerical evaluation and comparison of the concepts can be obtained. This approach is considered to be the most advantage of the AHP over the other similar methods. However, the numerical evaluation and the priorities of attributes are highly depended on the main goal of the decision-making process. This is important because different overall priorities might potentially result in significantly different results. For instance, if we replicate the current research with the same number of criteria and the alternative, but recruiting different subjects, the overall finding and the results would be most likely different. The aggregation of the individual priorities into an overall result has to be performed also, as the analysis is done based on the opinion of a group of respondents and not just an opinion of a single decision maker. The aggregation function is done through three important properties (i) unanimity, (ii) homogeneity and (iii) reciprocity. However, the arithmetic mean and the geometric mean satisfy only the unanimity and the homogeneity when aggregating individual judgements but the geometric mean is the only choice if the objective is to ensure that reciprocity is also satisfied (Aczél & Saaty, 1983).

Data Collection

An online survey questionnaire is used for data collection between July and October 2014. A number of managers with more than 10 years of experience in mobile value-added services were contacted. Two experts in AHP research evaluated the draft version of the questionnaire to verify the accuracy of the items and to check for ambiguous statement. The respondents participated in this research were the mangers and researchers. All of them were involved in conceptualization, development and commercialization of different aspects of value added service and all of them were from India. They were contacted via email and phone offering them a URL link to the online questionnaire. To put the questions into context, we asked subjects to focus on their most important, recent service offering. Moreover, the authors asked subjects to focus on the service where their organization acted as the leader of the ecosystem. To explain the questionnaire and its context, the participants were offered an explanation of the research objective over the phone or in a face-to-face meeting. This was possible due to comparatively low number of participants required for this type of survey (i.e., AHP). We received, in total, 38 complete responses and the sample consistency ratio value was 0.053, which was well within the recommended value. Out of the 38 responses, 16 were from telecom service providers, 12 were from IT service providers or systems integrators, five were from value-added service providers and aggregators, three were from academic and research institutes, and two from application or gateway providers. In terms of functional background, 12 responses were from IT and Technology, 10 from product management, nine from strategy, five from sales and account management, and two from research departments. AHP does not require a representative sample because the focus is on the decision process instead of the representativeness of those involved as the experience with decision-making is far more important. The average industry experience (specifically in the value-added services) of the respondents was eleven years. Although this empirical study did not have a large number of responses, it still represents a well-balanced view of both the industry and the academia on the mobile platform because of the professional credentials of the 38 respondents as well as its focus on a single country (India).

DATA ANALYSIS AND RESULTS

The AHP analysis assigns a weight to each criterion. The sum of weights of all criteria on the same level always equals to 1. A weight can thus be interpreted as the relative importance or priority of that criterion as compared to other criteria on that level. In the research model, manage or improve central position, manage interdependencies and acquire complementary resources were identified as the first (highest) level roles for control mechanisms in a platform ecosystem. The findings show that manage or improve central position was considered to be the most important factor accounting for the highest weight (0.46). From the participants' view, the leaders design control strategy primarily to manage or improve its central position in the ecosystem, which allows them to capture higher value for themselves. The other factors i.e. acquire complementary resources and manage interdependencies received lower importance values (0.29 and 0.25) respectively (see Table 5). The priority weights of these two objectives are very close and the subjects considered them to have nearly the same importance.

Table 6 shows the overall weight of the second level of the AHP tree (i.e., alternatives) in relation to the three first level (attributes). The first and the second alternatives, i.e. customer access (0.131) and product definition (0.127) are related to the most important objective (i.e. manage or improve central position). Interestingly, the third most important alternative is partner capability (0.12), which belongs to acquiring the complementary resources attribute. Interface (mechanisms to ensure data and information flow between the partners) and role fulfilment (mechanisms to define and enforcing specific role for each partner for the service) belong to the same attribute (i.e. managing interdependencies), had the lowest priority weight from the control portfolio design perspective, see Table 6.

Table 5. Priority ranking and weight of main factors

Priority ranking	First-level (attributes)	Weight
1	Manage its central position	0.46
2	Acquire complimentary resources	0.29
3	Manage interdependencies	0.25

Table 6. T Priority ranking and weight of attributes

Priority ranking	Second-level attributes	Relative weight	Main category
1	Customer Access	0.131	Manage Central Position
2	Product Definition	0.127	Manage Central Position
3	Partner Capability	0.120	Acquire Complimentary Resources
4	Revenue Share	0.119	Manage Central Position
5	Customization	0.099	Manage Interdependencies
6	Partner Experience	0.087	Acquire Complimentary Resources
7	Payment Method	0.087	Manage Central Position
8	Integrated Partner	0.080	Acquire Complimentary Resources
9	Role	0.075	Mange Interdependencies
10	Interface	0.075	Mange Interdependencies

DISCUSSIONS

This study extends the organizational control theories in the context of the mobile ecosystem. In organizational control theory, control is primarily seen as a mechanism to achieve cooperation among entities having divergent views (Ouchi, 1979). Control, in addition to this objective, helps the ecosystem owner to achieve two other important objectives: (1) acquiring complementary partners and (2) capturing higher value by managing or improving the central position in the platform ecosystem. These objectives are specific to the business models of ecosystems and platforms, and need to be assessed within that context. As ecosystems promote innovation, and ecosystem owners do not have all the resources required for innovation, it is very important to attract niche players with deep expertise in some narrow areas (Iansiti & Levien, 2004b). The input control is widely used in this context, which is not so prevalent in Information Systems development (Tiwana et al., 2010). The objective of managing central position within the ecosystem, which indicates a sense of competition among ecosystem partners, is perceived to have the highest priority role of control in this research. The organizational control literature does not deal with this objective in detail. Similarly, existing research on platform theory do not adequately address the possible competition between platform owners and complementors (Gawer, 2014) or intra-platform competition (Tiwana, 2015). Therefore, in that way, it extends our understanding of interaction between platform leaders and other partners by highlighting the tension between them in sharing the value generated from collaboration. In the context of an ecosystem, the finding of this research is in sync and validates the existing ecosystem theory, as the ecosystem theory also highlights the competition among ecosystem partners even while collaborating (Iansiti & Levien, 2004a, 2004b).

In terms of the second level of the AHP model (referred to as alternatives) the two highest priority design factors are: (1) customer access (the ability to own the customer and restrict access to them by other partners) and (2) product definition (the ability to define products, their variants and their pricing). This is in line with the findings of previous studies, where ecosystem leaders protect the important roles or gatekeeper roles (Ballon & Walravens, 2008) and the competition between ecosystem partners over owning direct contact with customers (Ballon, 2007). An item perceived to be the less important, i.e. interface (mechanisms to ensure data and information flow between partners required for the service) may not be actually unimportant from the business model design perspective. The agreed platform interface allows external developers to build complementary functionalities without being concerned about the inter-operability with other modules (Bosch, 2010). The low importance cited to this feature can be attributed to the fact that platform architecture governance anyway ensures modularity and stable interfaces. As mentioned above, the architecture of the platform underlying the ecosystem allows different partners to focus on different components independently of other partners, and that can be one of the key reasons for the low perceived critically of the interface.

The objective of managing current and future central position in the ecosystem is the most important aspect of platform governance. This activity can also include improving one's relative position in the ecosystems over time (Jansen & Cusumano, 2013). Many platform leaders equate the objective of managing central position with capturing higher value share. As a result, their role can be correlated to the landlord or dominators as mentioned in ecosystems theory (Iansiti & Levien, 2004a; Zhang & Liang, 2011). While, the landlords or dominators capture maximum value for themselves, during the process they may damage the ecosystems as well as their own prospect (Huang et al., 2013). by discouraging innovation from other players. By encouraging diversity in resources and fairness in value sharing, keystone players improve the overall health of the ecosystems. In doing so, they ensure their own survival and as well as increased value creation potential (Iansiti & Levien, 2004a; Zhang & Liang, 2011).

CONCLUSION

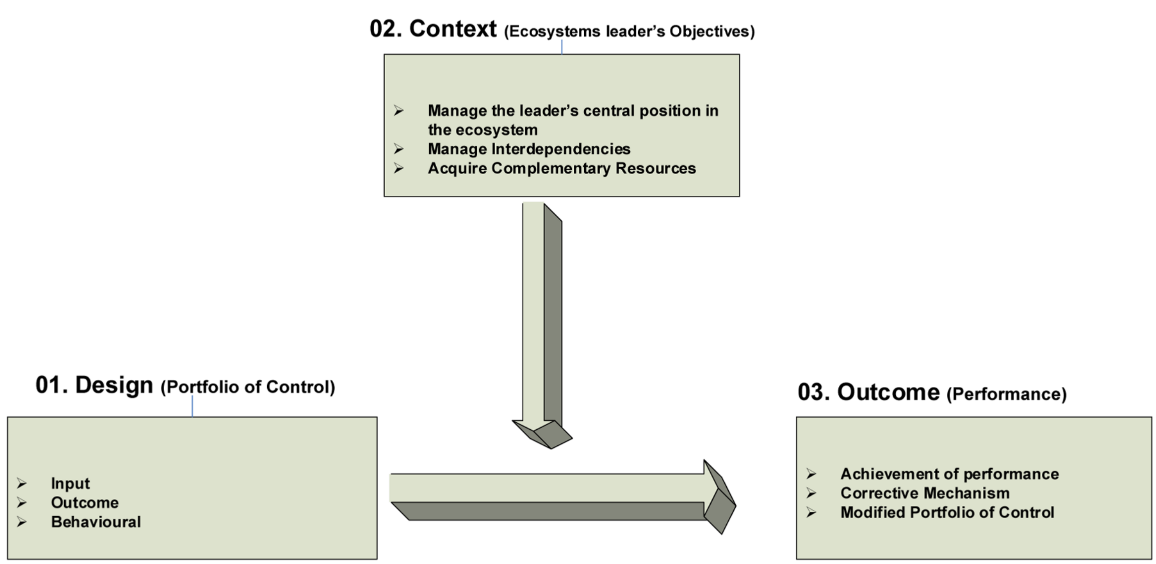
This chapter provides a formal method for ranking and prioritizing the critical design factors related to the portfolios of control of the mobile service industry. At the methodological level, the authors argue that the result obtained from Analytic Hierarchy Process (AHP) approach performs better than the results often obtained from a purely qualitative analysis. The AHP approach also works better than the other quantitative methods of assigning absolute priorities of each criterion (Zahedi, 1986). Since AHP allows experts to see and make comparisons of attributes relative to others (pairwise comparisons), it is easier to finalize their importance (Zahedi, 1986).

From the practitioner perspectives, this research provides a framework for designing and implementing control as shown in Figure 2, taking into account the relative importance of desirable outcomes. To create an effective control portfolio, the ecosystems leaders need to priorities control objectives or role specific to a scenario that one wants to achieve. Based on the identified control objectives, the ecosystems leader can mix different control types to create a control portfolio. These control portfolios are not static in nature (Mukhopadhyay et al., 2015). Based on the performances achieved, the control portfolios can be adjusted or rebalanced. Moreover, understanding the critical elements of the control strategy can provide important insights for managers and policy-makers alike, so that innovation can be accelerated. For example, innovation in mobile value-added services would have a positive impact on revenue, increase customer loyalty and improve brand image for mobile service providers (de Reuver et al., 2015).

FUTURE RESEARCH DIRECTIONS

This research has few limitations related to the methodology used and the cultural and institutional context, which can be addressed through further studies. With regard to the methodology, the representativeness of the subjects is not an issue, but the number of levels (attributes) and alternatives can be an issue. The

Figure 2. Deployment and monitoring of control portfolio based on control objectives



selection of attributes and alternatives is based on the sound theories, but in the complex decision-making context more attributes and alternatives could have been considered. Also with regard to the culture, decision-making processes and dominance of certain actors can be an artefact. Likewise, the institutional context, like Indian policy and regulation, competitor behavior, and consumer behavior might affect the results. Therefore, similar research in other cultural and institutional context might validate current findings. A further testing of the propositions, within a more international setting, would be required.

Furthermore, this study does not differentiate between ecosystems led by network operator, device manufacturer or the service providers. Ballon and Walravens (2008) found that these three ecosystems are significantly different in terms of strategies and business models. Further research on how control design priorities would vary for the ecosystems with different type of platform leaders, e.g. mobile operators, device manufacturers and content/service providers, would be interesting to investigate. Control mechanisms and their role would also vary in the context of open and closed platform, which needs further research.

The existing studies also support that governance mechanisms and control portfolios are not static and evolve over different phases of the product development and project (Choudhury & Sabherwal, 2003; de Reuver & Bouwman; 2012). The objectives for control portfolio also may change over different phases of mobile services exploration, implementation, and exploitation. In a case study, Mukhopadhyay et al. (2015) showed that on the one hand, attracting capable and right partners is the most important objective in the initial exploration phase, while managing the complex interdependency between partners becomes critical in implementation phases. In commercialization phase, capturing higher revenue share and interdependency management are both important. Therefore, there is also space for studies on understanding how the control portfolios, mechanisms, attributes and alternatives evolve over different phases of service design and development. Literature also suggests about the differential effects of control modes in the context of platform and ecosystems (Goldbach & Kemper; 2014; Manner et al., 2012, Mukhopadhyay et al., 2016a). Therefore, further research on establishing a link between the choice of a particular form of organizational controls employed by the leader of the ecosystems and the achievements of leader's specific objectives might be developed in more detail. This would be helpful for managers in designing, implementing portfolios of control and allow them to take corrective measures, when objectives are not met in multi-organizational collaboration.

The new studies confirm that while in an ecosystem, it is extremely important to attract external complementary capabilities; too much focus on the scale of their participants can also be misleading (Kim, 2017). Overcrowding with participants with similar capabilities may force few of the better partners to look for alternate platforms; increases intra-platform competition and can prevent sustainable growth. So, additional insight is required, how input control can be used to acquire relevant capabilities without creating congestion or compromising on quality (Kim, 2017).

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