Mashup network ecosystem structure: A driving force of competitive actions?

by

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ABSTRACT

Over the last decade, the Internet has played host to an explosion of developer innovation in the form of mashups. However, few empirical studies have explored the nature of competition within the mashup ecosystem, which grows by virtue of developers' independent choices and where API providers function as both competitors and complementors. This study explores competitive dynamics and social network analysis within the context of the mashup ecosystem. Hypotheses propose associations between competitive action and network structure constructs. 1277 blog postings are analyzed to collect competitive actions taken by 8 mapping APIs, and social network analysis is performed on the mashup-API network. The results show that API providers perform competitive actions that fall into six categories: marketing, product development, service, legal, capacity and success; that observed actions are performed in specific patterns, and that a limited relationship does exist between network position and competitive action in this context.

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1 INTRODUCTION

Over the last decade, the Internet has played host to an extraordinary explosion of developer innovation in the form of mashups. Built using web services exposed by third party data providers via application programming interfaces (APIs), mashups combine data from multiple APIs into innovative web applications that often meet a long tail need (Yu & Woodard, 2009). The classic example is the combination of an online mapping service and classified listings, where the listing locations are plotted on the map. Mashups have been hailed as the next new software development model (Hinchcliffe, 2007); ProgrammableWeb.com, an online repository tracking the mashup community, reports over 4000 mashups developed as of June 2010, and counting (Musser, 2010).

Mashup developers can be considered a type of user-innovator (von Hippel, 2004), and are motivated by the enjoyment of niche, long-tail problem-solving and the opportunity to create novel applications with powerful, highly developed technologies (Floyd, Jones, Rathi, & Twidale, 2007). They are often willing to freely share their mashups, thereby building reputation (von Hippel, 2004), and have much to gain by "building on the shoulders of giants" (Hinchcliffe, 2007) and the massive amounts of data these giants – large and significant data providers – make available. However, owners of a valuable data repository can also benefit in very specific ways by offering a free, open interface to their data.

1. *Free advertising and exposure*. Mashups, especially those targeting a long-tail need, can reach a much wider audience.
2. *A new source of revenue*. Many data providers place a cap on permitted API call volumes to keep costs down. Once traffic hits a volume threshold, a monetization opportunity appears.

3. *Free research and development.* The mashup developer community acts as an extended R&D department. A data provider can observe successes and failures in mashup innovation and apply those insights to their own product development. For example, in 2006 Flickr released a geotagging feature to tag photos to a map location, after mashup developers combined of Flickr's API and the Google Maps API to achieve a similar result (Arrington, 2006).

ProgrammableWeb.com lists 33 APIs within the "mapping" category alone, presuming healthy competition amongst API providers and a certain overlap of data and service offerings. However, despite the explosive growth of the mashup ecosystem, few empirical studies have explored the nature of competition within this space.

Existing literature on inter-firm competition focuses on established, traditional industries such as those represented in the *Fortune 500* (Ferrier, 2002) and the automotive industry (Chi, Holsapple, & Srinivasan, 2007). Well-established competitive action categories have been developed (Ferrier, 2001) and extended within specific contexts such as open source companies (McInnis, 2008). Relationships have been established between competition and inter-firm network structure (Ferrier, 2001; Chi, Holsapple, & Srinivasan, 2007; Gnyawali & Madhavan, 2001; Gnyawali, He, & Madhavan, 2006; Andrevski, Ferrier, & Brass, 2007) .

However, an examination of the literature did not reveal an analysis of competitive actions, or their link to network structure, within the mashup ecosystem, which embodies a rich environment for research on the nature of innovation and competition (Weiss & Gangadharan, 2010). Few studies have focused on the dynamics between *complementors* who offer easily integrated products that jointly appeal to end users (Venkatraman & Lee, 2004); in the same vein, the dynamic of simultaneous cooperative and competitive interfirm relationships is just beginning to be understood (Gnyawali, He, & Madhavan, 2006). Indeed, the mashup ecosystem, wherein it is suggested that market share increases via independent preferential attachment ("rich get richer"), presents both a unique competitive environment and a long-tailed power-law distribution wherein a greater number of APIs are used by few mashups, and a smaller number of APIs are used by the majority of mashups (Weiss & Gangadharan, 2010; Yu & Woodard, 2009). Within such a distribution, a large proportion of high-degree and powerful "hubs" can be identified.

This thesis answers two research questions:

(i) What competitive actions are taken by API providers within the mashup ecosystem?

(ii) Is there a link between competitive action and API affiliate network structure?

In examining these questions, this research will benefit API providers entering the mashup ecosystem by providing valuable insight into its competitive landscape. .

For the purpose of this research, the mashup ecosystem is defined as the combined mashup platforms, data providers and users that support the creation of mashups (Weiss & Gangadharan, 2010). The API affiliate network is defined as a projection of the mashup-API affiliate network to APIs, linking APIs that are used together in the same mashup (Weiss & Gangadharan, 2010).

A competitive action is defined by (Ferrier, 2002) as an externally directed, specific, and observable competitive move initiated by a company to enhance its relative competitive position. Competitive strategy is defined as the ordered pattern of repeatable competitive actions carried out in a strategic time (Ferrier, 2001). Data providers are defined as companies who expose data and/or services via a public web-based API.

1.1 Deliverables

This research has three deliverables:

1) An identification and categorization of competitive actions within the mashup ecosystem
2) Social network analysis of the API affiliate network
3) Results of hypothesis testing and regression analysis

1.2 Contribution

This research makes three contributions.

1. An extension to established competitive dynamics research and research tools, in the context of a unique, cutting-edge web-based industry
2. A categorization of competitive actions at the API level of analysis
3. An initial understanding of the influence of network position on competitive actions launched by competitor APIs. APIs that are structurally similar (that is, they are frequently combined with the same other APIs) display very different competitive action patterns. Additionally there is some evidence that broader popularity within the mashup ecosystem may enable or drive an increased volume of competitive actions.

1.3 Relevance

There are at least three groups that will be interested in this research.

First, researchers will be interested in the process that has been used to evolve an existing categorization and to capture competitive actions using publicly available information. As well, the massive growth and accessibility of the mashup ecosystem offers compelling new research avenues within network, user innovation and competitive dynamics theory.

Top management teams of data providers that offer an API may also be interested. This research provides insight into the characteristics and patterns of competitive actions taken by both entrants and incumbents in the mashup ecosystem.

Data providers with a new API on offer might also leverage this research to position themselves advantageously within the mashup ecosystem.

1.4 Organization

This thesis is organized into six chapters. Chapter 1 is the introduction. Chapter 2 reviews the relevant literature. Chapter 3 presents the variable constructs and hypotheses. Chapter 4 presents the method used to undertake this research. Chapter 5 presents the results. Chapter 6 discusses the results. Finally, Chapter 7 provides the conclusions, describes the limitations of the study, and identifies opportunities for future research.

2 LITERATURE REVIEW

This chapter is organized into the following sections. The first three sections review the literature on competitive dynamics, user innovation and the uniqueness of the mashup ecosystem. The fourth section provides the lessons learned from the literature.

2.1 Competitive actions

A recent evolution within competitive dynamics literature has been the study of competitive action as a dynamic process theory of competitive interaction, wherein strategy is defined as an *ordered pattern of repeatable competitive actions carried out in strategic time* (Ferrier, 2001).

Prior research conceptualizing firm strategy as competitive action focused on individual action-reaction dyads (Chen, Smith, & Grimm, 1992) and aggregations of actions over finite time periods, such as the repertoire-year and the aggregation of action categories over a firm-month (Ferrier, Smith, & Grimm, 1999; Chi, Holsapple, & Srinivasan, 2007). However, these levels of analysis "cannot completely inform scholars as to the process of how a pattern of competitive moves impacts performance" (Ferrier, 2001).

In contrast, the process level of analysis explores strategy as it unfolds over time; the *order* of events within a sequence matters. The characteristics of sequences of actions as they unfold over time are strong predictors of firm performance (Ferrier, 2001; Ferrier, 2002).

A sequence of competitive actions is comprised of a series of individual competitive actions, defined as externally directed, specific, and observable competitive moves initiated by a firm to enhance its relative competitive position (Ferrier, 2001). The following characteristics of competitive action sequences have been established:

Table 1: Competitive action measures in relation to firm performance and network structure

Sequence characteristic	Definition	Link to other variables
Strategic intensity (Ferrier, 2002)	The extent to which a firm carries out a large number of competitive actions in rapid succession.	Linked positively to a decrease in rival's stock market returns
Strategic complexity, or complexity-of-action repertoire (Ferrier, 2002), (Ferrier, 2001), (Chi, Holsapple, & Srinivasan, 2007)	The extent to which a sequence of actions is composed of actions of many different types (as opposed to a simple action sequence consisting of a few types).	No significant impact on rival's stock price; U-shaped relationship with market share gain
Strategic unpredictability (Ferrier, 2002), (Ferrier, 2001)	The extent to which a firm's sequential order of competitive actions is dissimilar from one period to the next.	Linked positively to a decrease in rival's stock market returns; U-shaped relationship with market share gain
Strategic heterogeneity (Ferrier, 2002)	The extent to which the focal firm's sequence of competitive actions is dissimilar from that of its rival.	No significant impact on rival's stock price
Attack volume (Ferrier, 2001),	The total number of competitive action events that comprise each attack.	Linked positively to market share gain
Attack duration (Ferrier, 2001)	The time elapsed from the beginning of a sequence of action events to the end of the sequence.	Linked positively to gain in market share.
Action pattern similarity (Chi, Holsapple, & Srinivasan, 2007)	The similarity between action patterns of two firms in a given time	Linked positively to IOS network structural similarity
Action heterogeneity (Chi, Holsapple, & Srinivasan, 2007)	The extent to which the entire set of competitive actions carried out by a firm in a given time deviates from the industry norm	Linked positively to IOS network degree centrality
Action volume (Chi, Holsapple, & Srinivasan, 2007)	The total number of competitive actions carried out by a firm in a given time	Linked positively to IOS network degree centrality

Furthermore, the individual competitive actions themselves are broken down into established categories (Ferrier, 2001).

Table 2: Established competitive action categories

Competitive action	Definition	Keywords
Pricing	Increasing, or lowering the price of a product or service sold to a customer. Offering a discount or rebate on the purchase of a product.	price, rate, rebate, discount
Marketing	The creation and distribution of advertisements or promotions as part of a campaign.	ads, spots, promote, distribute, campaign
Product	The introduction, launch, roll-out or unveiling of a product.	introduce, launch, unveil, rolls out
Capacity	The increase of manufacturing/creation or service capacity or output.	raises, boosts, increases [with capacity or output]
Service	The introduction, launch, roll-out or unveiling of a service.	service, warranty, guarantee, financing
Signaling	Open statement of a company promising or describing an upcoming (or current) goal.	vows, promises, says, seeks, aims

(McInnis, 2008) found that researchers subsequent to (Ferrier, 2001) have used or augmented these categories for specific industry contexts. For example, (Boyd & Bresser, 2008) introduced new action categories that are required for their study of the retail industry. Those categories are: (i) range; (ii) format; (iii) geographic; (iv) direct channels; (v) merger and acquisition; and (vi) legal. Likewise, (Chi, Holsapple, & Srinivasan, 2007) introduced new action categories for the automotive industry. These categories are: (i) procurement; (ii) product development; (iii) production; (iv) logistics; (v) marketing and sales; and (vi) service.

2.2 Competitive actions and inter-firm network structure

Seminal research in competitive dynamics examines industry structure in the context of five forces that shape competition and profitability therein. Companies can position themselves within the industry structure to both defend against and exploit these forces, which include (i) threat of new entrants, (ii) bargaining power of suppliers, (iii) bargaining power of customers, (iv) threat of substitutes, and (v) competitor rivalry (Porter, 1979). Industry structure is analyzed in the context of these five forces and is not conceptualized as an inter-firm network. Additionally, this perspective does not consider a collaborative or complementary relationship also existing between competitors.

More recently, relationships have been established between inter-organizational network structure and competitive actions, wherein the network includes competitors (Gnyawali & Madhavan, 2001), co-opetitive partners (Gnyawali, He, & Madhavan, 2006), or alliances (Andrevski, Ferrier, & Brass, 2007) .

Competitive action is dictated by structural embeddedness (Gnyawali & Madhavan, 2001) wherein competitors are thought to be embedded in a network of relationships that influences their competitive behaviour. Network structure influences resource flows, awareness of competitive context, intention to act, and firm actions thus taken to compete against rivals; resource flows include information, asset and status flows (Chi, Holsapple, & Srinivasan, 2007; Gnyawali & Madhavan, 2001). In the context of a co-opetitive network, firms that are highly central and structurally autonomous demonstrate higher volume and versatility of competitive action (Gnyawali, He, & Madhavan, 2006).

The study of interfirm network structure has also been extended to electronic networks. (Chi, Holsapple, & Srinivasan, 2007) found that competitive behaviour is significantly influenced by inter-organizational system (IOS) network position in the automotive industry; in this case the IOS network provided performance-enhancing resources and a market monitoring mechanism for firms.

2.3 Uniqueness of the mashup ecosystem

To understand and characterize the mashup ecosystem, researchers need to examine the interlinked decisions by which mashup developers choose APIs, API providers expose data, and end users consume mashups; this suggests studying mashups and APIs as a single evolving network rather than independent populations of discrete entities (Yu & Woodard, 2009). This network-based approach invites the use of social network analysis techniques to explore how APIs are connected via mashups and the overall characteristics of the network, which presents a unique environment for the study of competitive dynamics.

2.3.1 Growth by independent choices

Firstly, the mashup ecosystem is an innovation network wherein firms cannot directly influence the formation of links; the network grows by virtue of mashup developers' independent choices instead of purposeful strategic alliances in inter-firm networks. Such an innovation network represents a unique situation wherein "firms lack the authority to issue commands and autonomous network members are not obliged to obey" (Dhanaraj & Parkhe, 2006).

2.3.2 A small world where the "rich get richer"

Secondly, the mashup ecosystem exhibits specific characteristics – most notably a power-law distribution, a small-world property and "rich get richer" growth pattern, wherein the majority of mashups use a small number of APIs and API popularity is self-reinforcing (Weiss & Gangadharan, 2010; Yu & Woodard, 2009). Dominant hubs within the ecosystem, such as the Google Maps API, attract niche data providers as complementors, and the strong positions of these data providers in the network are mutually reinforcing (Weiss & Gangadharan, 2010). Two APIs are more likely to be used together in the same mashup if they have been used together previously, possibly due to imitation and developer preference for proven combinations of APIs (Weiss & Gangadharan, 2010). Additionally, the small-world property, indicating that nodes are more closely connected than expected given their density and clustering, may suggest that APIs with very different functionality are more likely to be combined than otherwise expected (Yu & Woodard, 2009).

2.3.3 API providers as complementors

Thirdly, APIs function as both competitors and complementors in the mashup ecosystem; the combination of two or more datasets into a mashup is more powerful than a lone dataset. In the software platform context, prior research has examined drivers of platform adoption by complementors and has encouraged the provisioning of APIs (Cusumano & Gawer, 2003; West, 2003); however, few studies have focused on the dynamics between *complementors* who offer easily integrated products that jointly appeal to end users (Venkatraman & Lee, 2004).

2.3.4 Resource flows

Fourthly, resource flow between APIs differs from that within inter-firm networks, where a direct industry relationship between nodes is assumed. In an inter-firm network, three types of resource flows occur between partners: information flows, asset flows and status flows (Gnyawali & Madhavan, 2001). A firm's ability to access and use these resources varies based on its structural position in the network. In the mashup ecosystem, however, links represent indirect relationships formed by independent mashup developer decisions. The following table suggests resource flows within the mashup ecosystem as a variation on the established inter-firm network flows.

Table 3: Suggested resource flows in the mashup ecosystem

Interfirm resource flows (Gnyawali & Madhavan, 2001)	Suggested variations within mashup ecosystem
Information flow, where information and knowledge about competitive intent, strategies and resources flows between connected firms	*Innovation flow*, where the observed integration of two APIs may inspire imitation and innovation by API providers, in the form of future enhancements, and mashup developers alike
Asset flow, where resources such as money, equipment, technology and organizational skills flow between connected firms	*Experience flow*, where accumulated developer experience in integrating two APIs influences the development of new mashups using those APIs
Status flow, where legitimacy, power and recognition flow from high-status firms to lower-status firms	*Status flow*, where a high-status API bestows that status on a lower-status API with which it is combined in a mashup (by association)

2.3.5 User innovation

Lastly, mashup development can be considered part of the democratization of innovation, a trend driven by the steadily improving design capabilities (innovation toolkits) that technology advances make possible for users, and the increasing ability for users to combine and coordinate their innovative efforts over the Web (von Hippel, 2004). Within this paradigm, researchers have been surprised by user-innovators' willingness to freely reveal what has been developed at private cost (von Hippel, 2004). The mashup ecosystem remains a user-innovation driven space where the key resource – data – is made available through APIs and the motivation and benefit to both freely offer data and build new applications differs significantly from a scenario where profit is the direct currency (Hinchcliffe, 2007; Floyd, Jones, Rathi, & Twidale, 2007; von Hippel, 2004).

2.4 Lessons Learned From the Literature Review

1. The mashup ecosystem presents a unique competitive environment, with characteristics that differ from those of inter-firm networks formed by intentional

strategic alliances and earlier conceptualizations of industry structure that do not directly address these characteristics, which include:

a. Network growth by independent developer choice and motivations specific to the phenomenon of user innovation
b. A power-law distribution of mashups over APIs and a "rich get richer" growth pattern
c. A concurrently competitive and complementary relationship between API providers
d. Unique resource flows between API providers

2. An examination of the literature did not reveal an analysis of competitive actions, or their link to network structure, within the mashup ecosystem. Competitive dynamics have been well-studied in other contexts and links between competitive actions and both firm performance and inter-firm network structure have been well-established.
3. A link between competitive action and inter-firm electronic network structure has found support in the automotive industry context.
4. Established competitive action categories do not fit all industry contexts.

3 VARIABLE CONSTRUCTS AND HYPOTHESES

3.1 Terminology: API and API provider

It is important to make a distinction between API and API provider. An API provider, such as Google, is an organization who may offer one or many APIs, such as the Google Maps API. An API is the individual unit examined in this research and the network participant; however, competitive actions are undertaken by the API *provider* - hence the need to filter on competitive actions pertinent to the API in question. In the context of this study, each API provider only offers one API of the specified mapping type.

3.2 Network structure

In analyzing coopetitive network structure, unique structural characteristics of collaborative linkages between competing firms can be examined (Gnyawali, He, & Madhavan, 2006). The influence of a firm's position in the network on its access to resources and reaction to competitors can also be studied (Chi, Holsapple, & Srinivasan, 2007). In the same way, the study of mashups and APIs as a single network, rather than as independent populations of discrete entities, is advocated as a way to examine how APIs become connected through mashups, and how these links shape the overall network structure and popularity of APIs (Yu & Woodard, 2009).

The mashup-API affiliation network captures the relationships between mashups and APIs; a link in this network indicates which APIs are used in which mashups. A projection of this network to the API affiliate network links APIs that are used together in the same mashup (Weiss & Gangadharan, 2010). Analysis of this network reveals the different ways in which mashup developers combine APIs to create original applications (Yu & Woodard, 2009) – specifically, an API's access to resources, its popularity, the number of times it has been combined with other APIs, and the diversity of those combinations. Thus, this research will focus on the API affiliate network which includes all APIs that are used together with at least one other API in a mashup.

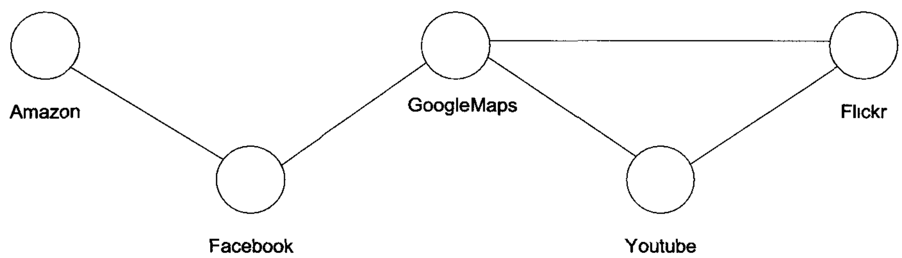

Figure 1: A subset of the API affiliate network

3.2.1 The API affiliate network as an unweighted graph

The API affiliate network contains undirected parallel edges which represent different mashups in which the same two APIs were used together. Some studies have suggested the usefulness of analyzing such a network as an unweighted multigraph, where n parallel edges can exist between two vertices, each with weight 1. Network analysis techniques normally applied to unweighted graphs could thus be applied to the multigraph as well, ensuring the rich data encapsulated in edge weights is not lost (Newman, 2004).

However, this research considers API affiliate network links as unweighted, single edges. Including multiple parallel edges in the network highlights an API's overall popularity in mashup usage. However, particularly in calculating degree centrality, including multiple parallel edges renders indistinguishable the extent to which APIs are connected to other *different* APIs – an important factor in indicating breadth of developer experience gained, exposure across the ecosystem and opportunity to observe successful combinations that may lead to new features. Additionally, the network metrics used in this study are normally applied to unweighted graphs.

Therefore, within this research, network structural analysis is performed on the API affiliate network represented as an undirected, unweighted graph with single edges.

3.2.2 Structural property measures

This research adopts four structural property measures that represent three levels of structural properties (firm-level, pair-level and network-level) in terms of three network constructs: (1) structural similarity (a pair-level structural property), (2) degree centrality (a firm-level structural property), (3) betweenness centrality (a network-level structural property), and (4) eigenvector centrality (a network-level structural property).

Previous studies show that these structural properties have significant influence on firm behaviour and resulting firm performance (Gnyawali & Madhavan, 2001). Using these measures, one can compare and examine the relative positions of the APIs in the affiliate network and their influence on resource flow, developer experience, popularity, innovation and resulting competitive actions.

- *Structural similarity* – In an inter-firm network, structural similarity between two firms indicates they share a similar pattern of relations with others in a network, and they may or may not have direct links with each other (Chi, Holsapple, & Srinivasan, 2007). In the API affiliate network, structural similar APIs are combined with many of the same other APIs in mashups, indicating which API combinations are building developer experience and popularity.

- *Degree centrality* – In an inter-firm network, degree centrality measures the extent to which a firm is directly linked to other firms in a network, thus measuring a firm's ability to directly access resources in that network (Chi, Holsapple, & Srinivasan, 2007; Gnyawali & Madhavan, 2001). In the API affiliate network, degree centrality measures the extent to which an API has been used with many *different* other APIs, indicating the breadth of developer experience gained, exposure across ecosystem and opportunity to observe successful combinations that may lead to new features. As such, degree centrality could also be considered a proxy measurement for access to experience and innovation flow within the mashup ecosystem.

- *Betweenness centrality* – In an inter-firm network, betweenness centrality measures the extent to which a firm falls on the shortest paths of pairs of other firms in a network – between each other pair of actors - thus measuring a firm's ability to acquire resources in comparison to other firms in the network (Chi, Holsapple, & Srinivasan, 2007). In the API affiliate network, betweenness centrality indicates an API provider's ability to gain resources (experience, status and innovation) from combinations with other APIs, in comparison to others in the network.

- *Eigenvector centrality* – Eigenvector centrality is a measure of the significance of a node in a network, whereby relative scores are assigned to all nodes such that links to high-scoring nodes contribute more to a node's score than equal links to low-scoring nodes – a weighted sum of not only direct connections but indirect connections of every length, taking into account the entire pattern in the network (Bonacich, 2007). This centrality measure evokes the strategic involvement of a node in many *significant* ties (Gnyawali & Madhavan, 2001). In the API affiliate network, an API with high eigenvector centrality is connected to many other different APIs which are, in turn, connected to many others and so on. This measure indicates a network-wide centrality, whereas degree centrality measures local centrality only. Additionally, assuming API status is at least partially bestowed and conveyed by its popularity in combination with many different APIs, eigenvector centrality could be considered a proxy measurement for access to status flow.

3.3 Competitive action

This research focuses on an API provider-level analysis of competitive action - that is, the entire set of competitive actions specific to an API carried out by an API provider during the given time period. The researcher has selected the characteristics of competitive action that prior research has identified as the most robust constructs: action volume, complexity-of-action repertoire, and action heterogeneity.

- *Action volume* Action volume measures the total number of competitive actions carried out by a firm in a given time (Chi, Holsapple, & Srinivasan, 2007). Research indicates action volume has a strong impact on firm performance and market share (Ferrier, 2002; Ferrier, Smith, & Grimm, 1999). In this research, action volume measures the total number of competitive actions specific to an API carried out by an API provider during the given time period of 5 years.

- *Action heterogeneity* Action heterogeneity measures the extent to which the entire set of competitive actions carried out by a firm in a given time deviates from the industry norm (Chi, Holsapple, & Srinivasan, 2007). Research indicates action heterogeneity has a strong influence on market share (Ferrier, 2002; Chi, Holsapple, & Srinivasan, 2007). In this research, action heterogeneity measures the extent to which the entire set of competitive actions specific to an API carried out by an API provider during the given time period of 5 years deviates from the industry norm.

- *Complexity-of-action repertoire* Complexity-of-action repertoire measures the extent to which a series of competitive actions carried out by a firm in a given time comprises a wide, rather than narrow, range of different action types (Chi, Holsapple, & Srinivasan, 2007). Research indicates complexity-of-action repertoire is a predictor of firm performance and has an influence on market share (Ferrier, 2001; Ferrier, 2002; Ferrier, Smith, & Grimm, 1999). In this research, complexity-of-action repertoire measures the extent to which a series of competitive actions specific to an API carried out by an API provider during the given time period of 5 years comprises a wide, rather than narrow, range of different action types.

- *Action pattern similarity* Action pattern similarity measures the similarity between two firms' competitive action patterns in a year (Chi, Holsapple, & Srinivasan, 2007). In this research, action pattern similarity measures the similarity between two API providers' API-specific competitive actions in the given time period of 5 years. As action pattern similarity is calculated on a month-by-month basis, this measure captures action sequence as a monthly aggregation, and not at the individual action level.

3.4 Hypotheses

Structurally similar firms occupy similar resource positions in a network and interact with similar others in similar ways; these firms will tend to have similar attitudes and access to resources, and often imitate each other (Gnyawali & Madhavan, 2001). In the mashup ecosystem, structurally similar APIs have been combined with the same other APIs – for example, two lesser known APIs may both have been combined in a mashup with the well-known Google Maps API. As such, both lesser known APIs enjoy the same experience, status and innovation resource flows that come from the link to Google Maps. This similar resource profile can lead to similar awareness of opportunities and technological developments and similar promotion and profile within the mashup developer community – thus shaping an API provider's competitive activity.

Therefore, the following hypothesis is suggested:

> *Hypothesis 1: All else being equal, structural similarity between a pair of APIs in the API affiliate network is positively associated with their action pattern similarity.*

A node with high degree centrality in a network has access to a greater volume of resources, and this resource asymmetry between competitors influences competitive behaviour (Gnyawali & Madhavan, 2001). Similarly, a firm with high eigenvector centrality has access to a greater volume of resources, but also a greater volume of indirect resources by virtue of greater *significant* ties. A firm with high betweenness centrality has a greater span of structural holes in a network. Firms in clusters on either side of a structural hole have access to different resource flows; a firm that spans a structural hole has access to resources on both sides – the more holes spanned, the more resources accessed (Chi, Holsapple, & Srinivasan, 2007).

Through greater access to resources, earlier knowledge of technological developments, alertness to competitive environment and higher status, a firm with high degree centrality is enabled to undertake a wider range and higher volume of competitive actions (Chi, Holsapple, & Srinivasan, 2007). Access to diverse knowledge through a diverse set of alliance partners, spanning a broad range of functions, increases a firm's ability to launch a greater number and variety of competitive actions (Andrevski, Ferrier, & Brass, 2007). Additionally, both degree and betweenness centrality have been associated with innovation output in collaboration networks (Ahuja, 2000).

Similarly, in the mashup ecosystem, the direct link to diverse API combinations and earlier access to developer innovation (both via observation and access to resources such as developer forums) broadens an API provider's range and differentiation of competitive actions. Earlier access to developer innovation also positions an API provider well for initiating competitive actions in the form of new features and community engagement, and can provision competitive intelligence surrounding other APIs – both competitors and complementors. Lastly, high status conferred on a highly central API by virtue of popularity and association with another high status API strengthens its position and motivation for launching competitive actions.

Therefore, the following hypotheses are suggested:

Hypothesis 2: All else being equal, degree centrality is positively associated with (a) action volume, (b) complexity-of-action repertoire, and (c) action heterogeneity.

Hypothesis 3: All else being equal, betweenness centrality is positively associated with (a) action volume, (b) complexity-of-action repertoire, and (c) action heterogeneity.

Hypothesis 4: All else being equal, eigenvector centrality is positively associated with (a) action volume, (b) complexity-of-action repertoire, and (c) action heterogeneity.

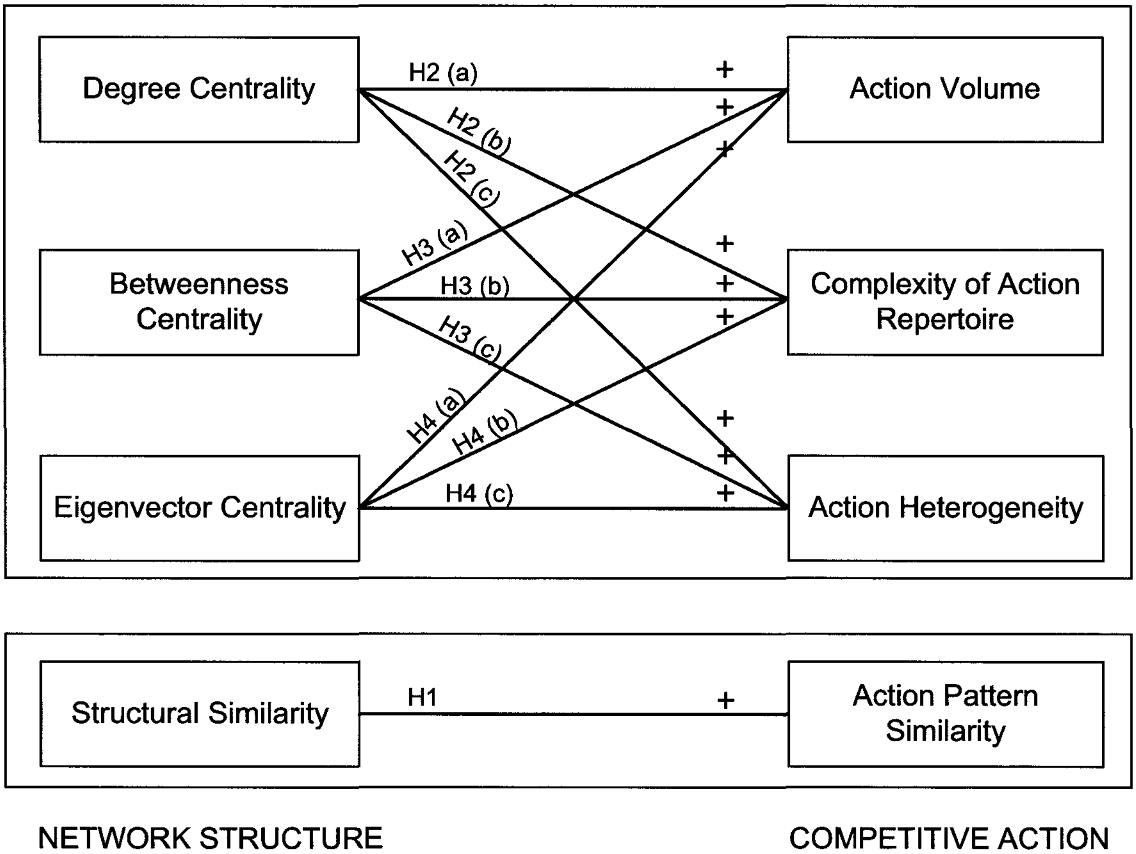

Figure 2: Hypothesized relationships between network structure and competitive action

3.4.1 Control variables

All hypotheses are proposed with the explicit assumption that all other factors are controlled. Certain factors may influence competitive action, such as API provider size, age and diversity of offerings; for example, Google Maps API is provided by Google, a well-established and dominant corporation with many more resources, partnerships, and other web-based offerings than a young, open source startup such as Geonames. The term "all else being equal" is stated in the hypotheses to indicate that the model holds when API provider size, age and diversity of offerings are controlled.

4 RESEARCH METHOD

This chapter is organized into the following sections detailing the research method. The research method used follows the approach of (Ferrier, 2001) for categorization of news articles into competitive actions via structured content analysis.

The following steps were undertaken in this research:

1. Specify unit of analysis, study period and sample selection criteria
2. Identify sample of APIs and online sources of competitive actions
3. Automated data collection from online sources
4. Manual content analysis to categorize 1277 blog postings from 15 online sources into categories of competitive actions; two iterations of refinements
5. Operationalize dependent and independent variables and perform hypothesis testing
6. Describe results and observations
7. Provide observations and insights to audience

4.1 Unit of analysis, study period and sample selection criteria

The unit of analysis was a mapping-related API. The mapping category of API was chosen for three reasons: (a) two thirds of all mashups reported by ProgrammableWeb make use of at least one mapping API; (b) the ability to control for service and functionality offering by selecting APIs with very similar offerings; and (c) the need to control scope due to the effort of manually categorizing blog posts into competitive action categories.

The criteria for API selection were:

- The API had an entry in the ProgrammableWeb repository, in the mapping category
- The API offered similar functionality to the Google Maps API; that is, the API offered an online mapping service. This criterion is more specific than the "mapping" category on ProgrammableWeb which refers to a broader category of geo-related services, and ensures a one-to-one mapping of API to API provider to simplify the competitive context (competition occurs at the API provider level)
- The API had at least one mashup registered in ProgrammableWeb
- At least one public, freely available online source contained a chronological record of the API provider's competitive activities related to the specific API between 2005 and 2010

The study period was from October 2005 to February 2010. Generally the mashup ecosystem took root and began to grow in 2005 and more precisely, the earliest API was added to the ProgrammableWeb database on June 2, 2005 and the earliest competitive actions collected from online sources dated from October 28, 2005 forward.

4.2 Sample of API providers and online sources

The APIs selected are outlined in Table 4 below.

Table 4: Summary of selected API provider characteristics

API	# total mashups on ProgrammableWeb (Feb 2010)	# competitive actions collected	Date API added to ProgrammableWeb
Google Maps	1927	283	05/12/2005
Bing Maps	181	541	02/12/2005
Yahoo Maps	133	57	19/11/2005
Mapquest	5	197	08/03/2008
Maponics	2	35	03/04/2009
Cloudmade	3	63	16/02/2009
Multimap	12	40	23/03/2007
Geonames	72	60	12/01/2006

The online sources include API provider-published blogs, comprising 87% of the online sources used, to ensure a rich source of actions taken by each API provider; web-based news outlets did not report as many actions as blogs published by the API providers themselves.

In general, blogs also represent easy, flexible, interactive and inexpensive publication of content for a very large audience on the Internet (Herring, Scheidt, Kouper, & Wright, 2006). Corporate blogs are a unique mixture of interpersonal and mass communication, and represent a potentially effective means of building relationships between a corporation and the public at large (Cho & Huh, 2010); blogs are primarily being used by businesses today as a marketing channel or to support marketing strategies such as branding, managing reputation and trust, niche marketing and gathering market intelligence (Chua, Deans, & Parker, 2009). Indeed, blogs have become an essential source of business news and information (Habermann, 2005), and as the strategies of companies are revealed in the content of their websites (Hicks, Libaers, Porter, & Schoeneck, 2006), we extend that to include the content of their blogs.

As such, this research makes an assumption that actions published on an API provider's blog comprise a competitive action, per this paper's definition of competitive action as an externally directed, specific, and observable competitive move initiated by a company to enhance its relative competitive position (Ferrier, 2001).

With the exceptions of the ProgrammableWeb blog and DirectionsMag, an online magazine covering geospatial technology, the online sources selected to collect competitive actions were published only by the API provider companies themselves. These sources are as follows:

Table 5: Summary of online data sources

Online Source	URL
Bing Maps map developer blog	http://www.bing.com/toolbox/blogs/maps/default.aspx
Google Maps API developer blog	http://googlemapsapi.blogspot.com/
Google geo developer blog	http://googlegeodevelopers.blogspot.com/
Yahoo developer blog	http://developer.yahoo.net/blog/
Yahoo geo blog	http://www.ygeoblog.com/
Mapquest blog	http://blog.mapquest.com/
Mapquest press releases	http://company.mapquest.com/press-releases.html
Mapquest developer blog	http://devblog.mapquest.com
Yahoo geo blog	http://www.ygeoblog.com/
ProgrammableWeb blog	http://blog.programmableweb.com/category/mapping/
Geonames blog	http://geonames.wordpress.com/
CloudMade blog	http://blog.cloudmade.com/
Multimap blog	http://blog.multimap.com/
Maponics blog	http://blog.maponics.com/
DirectionsMag news articles	http://www.directionsmag.com/

4.3 Data collection

4.3.1 Competitive actions

All online sources presented a blog-style format wherein each entry included a title and date of publication. A freeware screen-scraping tool called "screen-scraper" was used to automatically collect the titles and dates of all relevant entries within each online source. In some cases a filter was applied to the online source to ensure collection of entries related to the API provider in question.

This method produced 1277 blog entries pertaining to 8 APIs, published between October 2005 and February 2010.

4.3.2 APIs and Mashups

The ProgrammableWeb API was used to collect the full mashup and API repository as captured in February 2010, which was imported into a relational database (SQL Server 2008) for easy manipulation. Only mashups and APIs involved in at least one mashup combining at least two different APIs were used for data integrity purposes, resulting in a count of 574 unique APIs used in 1972 unique mashups.

For the purposes of this research, the Bing Maps API comprises the Microsoft Virtual Earth API as well; in the dataset, entries for these two APIs were merged. Microsoft Virtual Earth was renamed Bing Maps in May 2009, but ProgrammableWeb stores these APIs as two separate entries.

4.4 Manual content analysis

Prior studies have performed content analysis on corporate blogs of Fortune 500 companies, as an empirical investigation of positive, openness, social network and sharing tasks (Cho & Huh, 2010) and of content and design (Lee, Park, & Hwang, 2008). However, no prior studies had categorized corporate blog articles into competitive actions. This research uses a manual content analysis process similar to the structured content analysis used by (Ferrier, 2001) to categorize news headlines into competitive action types, and the method used by (Chi, Holsapple, & Srinivasan, 2007) to extract and read through news reports from multiple sources to categorize competitive action data.

Because actions in the mashup ecosystem had not yet been categorized in any way, this research used Ferrier's six categories as a baseline and cast a wide net.

The initial categorization attempt produced 60+ categories of actions, which were reduced to a more workable 16 categories. These 16 categories comprise actions that are seemingly unique to the mapping APIs and perhaps also to the blog style data sources. The 16 categories were then reduced to 6 categories related to competitive action categories used in prior studies (Ferrier, 2001; Chi, Holsapple, & Srinivasan, 2007; McInnis, 2008). Please see Appendix A for a sample categorization.

Table 6: Refined competitive action categories

Original 16 categories	Refined categories and definition
Feature enhancement	**Product development** - feature enhancement, new product, geographical expansion or new platform support
New product	
Increased geographical coverage	
New platform support	
Marketing	**Marketing** - any marketing activity (events, promotions), engagement of the developer community
Engaging the community	
Earning opportunity	
Mashup spotlight	**Success** - highlight or promotion of a mashup using provider's API
Mashup spotlight (tied to current event)	
Service disruption announcement	**Service** - tools, programs, announcements and documentation for developers
Instructional	
Certification program launch	
Developer tool launch	
Legal – TOS update	**Legal** - Any litigation activities or updates to terms of service
New partnership	**Capacity** - partnership or acquisition to increase output or service offerings
Acquisition	

4.4.1 Reliability Index

Using the above six refined categorizations, two fellow graduate students not involved with the original categorization separately categorized a representative sample (n=100) of blog articles.

This categorization yielded a value of 0.69 on Perrault and Leigh's (Perrault & Leigh, 1989) index of reliability, which indicates an acceptable reliability for exploratory studies.

The reliability index is calculated as follows:

Reliability index = $\sqrt{\left(\frac{F_0}{N} - \frac{1}{k}\right)\left(\frac{k}{k-1}\right)}$, where

- k = number of categories for the variable being coded
- F_0 = observed frequency of agreement between judges
- N = the total number of judgements made by each judge

4.5 Variable operationalization

The following variables were operationalized as follows for hypothesis testing. All network measurements were calculated using the statnet package in R statistical software (Butts, 2008).

4.5.1 Structural similarity

Similarity between two n-dimensional observations can be indicated by the Euclidean distance, normalized by the square root of the dimension size *n* (Chi, Holsapple, & Srinivasan, 2007). Two APIs are considered structurally similar if they are combined in mashups with the same other APIs, the same number of times.

The structural similarity between two APIs was calculated with the formula below, using a matrix plotting the 8 mapping APIs against the 574 other APIs in the dataset, with each value in the matrix representing the number of mashups combining those two APIs.

Structural similarity (X, Y) = $\sqrt{\frac{\sum_{i=1}^{n}(X_i - Y_i)^2}{n}}$ where

- X and Y = Two mapping APIs to be compared for structural similarity
- n = 574 (total number of APIs in the dataset)
- X_i = the number of mashups in which API *X* is combined with API *i*
- Y_i = the number of mashups in which API *Y* is combined with API *i*

An example of the structural similarity calculation between the Google Maps API and Bing Maps API is given below with sample data.

Table 7: Structural similarity calculation

574 APIs in dataset	# mashups combined with Google Maps	# mashups combined with Bing Maps	Structural similarity calculation
1) YahooTraffic	7	7	$(7 - 7)^2 = 0$
2) Digg	5	3	$(5 - 3)^2 = 4$
3) GoogleAdSense	33	5	$(33 - 5)^2 = 784$
....			
574) Ning	1	0	$(1 - 0)^2 = 1$
Structural similarity			$\sqrt{(0 + 4 + 784 + \ldots + 1)/574}$ **= 8.52**

4.5.2 Action pattern similarity

Action pattern similarity was calculated using Euclidean distance measure as described above, wherein each API can be considered an observation with 53 x 6 = 318 dimensions, following the method used in (Chi, Holsapple, & Srinivasan, 2007). Each dimension corresponds to competitive action category i in month j, where i = 1, 2, … , 6 (denoting the six competitive action categories of product development, marketing, success, service, legal, and capacity) and j = 1, 2, … , 53 (denoting 53 months between October 2005 and February 2010).

For this research, the similarity measure was calculated using the *proportional* difference in count of competitive actions per month between two mapping API pairs, where n = 318. Using the proportional difference (dividing the counts by total number of actions per API) normalizes the differences in action volumes collected between the APIs, which is significant in some cases. For example, 35 actions were collected for Maponics API versus 283 collected for Google Maps API.

Action pattern similarity (X, Y) = $\sqrt{\frac{\sum_{i=1}^{n}(X_i - Y_i)^2}{n}}$ where

- X and Y = Two mapping APIs to be compared for action pattern similarity
- n = 318 (6 action categories x 53 months)
- X_i = the number of actions collected for API *X* in category-month i
- Y_i = the number of actions collected for API *Y* in category-month i

The following diagram illustrates the proportional action patterns for Bing Maps and Google Maps over a period of four months in 2009. The differences between the red and blue bars are used in the Euclidean distance calculation above.

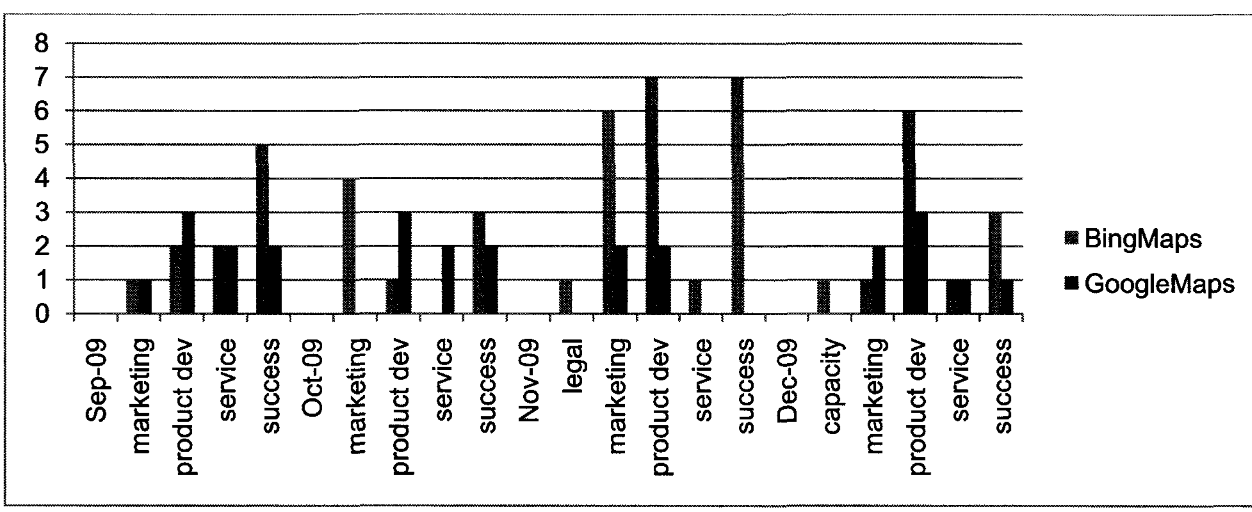

Figure 3: Histogram illustrating action patterns for Bing Maps and Google Maps

4.5.3 Degree centrality

Degree centrality measures the extent to which an API has been used with other APIs. Degree centrality scores of the 8 mapping APIs were computed with duplicate edges included as per this research's definition of degree centrality.

4.5.4 (Normalized) betweenness centrality

Betweenness centrality indicates an API provider's ability to gain resources (experience, status and innovation) from combinations with other APIs, in comparison to others in the network.

Following the method used by (Chi, Holsapple, & Srinivasan, 2007), this research normalizes the initial betweenness centrality measurements for the 8 mapping APIs by dividing the initial betweenness values by the maximum possible betweenness expressed as a percentage. Maximum possible betweenness is the maximum value when a node falls on all the shortest paths between any two pairs of other firms, expressed as a percentage.

Standard betweenness centrality for a graph $V = \sum_{s \neq v \neq t \in V} \frac{\sigma_{st}(v)}{\sigma_{st}}$ where

- σ_{st} = number of shortest paths from vertex *s* to vertex *t*
- σ_{st} *(v)* = number of shortest paths from vertex *s* to vertex *t* that pass through a vertex *v*

Maximum betweenness = (n-1)(n-2)/2 where

- n = # dimensions or APIs = 574

4.5.5 Eigenvector centrality

An API with high eigenvector centrality is an “important” node by virtue of its connections to many other APIs which are, in turn, connected to many others and so on. Eigenvector centrality can be interpreted as "recursive" or "reflected" degree - the extent to which a node has many ties to other central nodes (Butts, 2008). A node's eigenvector centrality is proportional to the sum of its connections to others, weighted by their centralities; scores range between 0 and 1.

Eigenvector centrality of node *i* = $\frac{1}{\lambda}\sum_{j=1}^{N} R_{i,j}x_j$ (Bonacich, 1987) where

- $R_{i,j}$ is the adjacency matrix of the network, where $R_{i,j} = 1$ if node *i* is adjacent to node *j*, and 0 otherwise
- N is the total number of nodes in the network
- x_j = is the eigenvector centrality score of the j^{th} node
- λ is a constant that ensures a non-zero solution

Eigenvector centrality scores of the 8 mapping APIs were calculated.

4.5.6 Action volume

Action volume is calculated at the total number of competitive actions initiated by an API provider, specific to an API, between October 2005 and February 2010.

4.5.7 Complexity-of-action repertoire

Complexity-of-action repertoire measures the extent to which a series of competitive actions specific to an API carried out by an API provider during the given time period of 5 years comprises a wide, rather than narrow, range of different action types. Following the method used in (Chi, Holsapple, & Srinivasan, 2007), this research calculates complexity-of-action repertoire using Shannon's index as measure of diversity, subtracting one correction factor.

Shannon's Index = $-\sum_{i=1}^{s} p_i \{\ln(p_i)\} - \frac{s-1}{2n}$ where

- s = 6 (number of competitive action categories)
- n = sample size = total number of actions per API provider
- $p_i = n_i/n$ where n_i actions are observed belonging to category i (i = 1, 2, … , s)

A simple example of this calculation for the Geonames API is provided below.

Table 8: Complexity-of-action repertoire calculation

Competitive action category	**Competitive action count**	**Shannon's Index calculation**
Marketing	9	${}^{9}/_{60} \times \ln {}^{9}/_{60}$
Product development	35	${}^{35}/_{60} \times \ln {}^{35}/_{60}$
Service	7	${}^{7}/_{60} \times \ln {}^{7}/_{60}$
Success	9	${}^{9}/_{60} \times \ln {}^{9}/_{60}$
SUM	60	-1.13
	Shannon's Index	$(-1 \times -1.13) - \frac{6-1}{2 \times 60} = 1.09$

4.5.8 Action heterogeneity

Action heterogeneity measures the extent to which the entire set of competitive actions specific to an API carried out by an API provider during the given time period of 5 years deviates from the industry norm. While the mashup ecosystem does not define a predictable annual action pattern as in the automotive industry, there are external factors that collectively influence API providers, such as world events, evolution of web standards and overall online trends. Following the method in (Chi, Holsapple, & Srinivasan, 2007), the industry norm is calculated by the taking the average competitive action count across the 8 mapping APIs per month.

Considering competitive action heterogeneity for APIs across 53 months, each firm is regarded as an observation with 53 x 6 = 318 dimensions. Each dimension corresponds to action category s in month t, where s = 1, 2, ..., 6; t = 1, 2, ..., 53. The action heterogeneity scores were calculated using the similarity measure taken between each API and the mean score.

Action heterogeneity (X, M) = $\sqrt{\frac{\sum_{i=1}^{n}(X_i - M_i)^2}{n}}$ where

- X = API for which action heterogeneity is to be calculated
- M = industry norm (mean score across 8 APIs)
- n = 318 (6 action categories x 53 months)
- X_i = the total actions for API X in category-month i
- M_i = the mean score for category-month i, calculated by dividing the sum of all competitive actions collected for all APIs in month-category i, by 8 mapping APIs

5 RESULTS

This chapter is organized into the following sections. The first section outlines the distribution of competitive actions for each of the 8 mapping APIs, across the 16 original competitive action categories. The second section outlines the results of hypothesis testing.

5.1 Competitive action distribution

The following figure indicates the distributions of competitive actions collected for the 8 mapping APIs; the histograms allow us to quickly compare the action distributions of the APIs to each other.

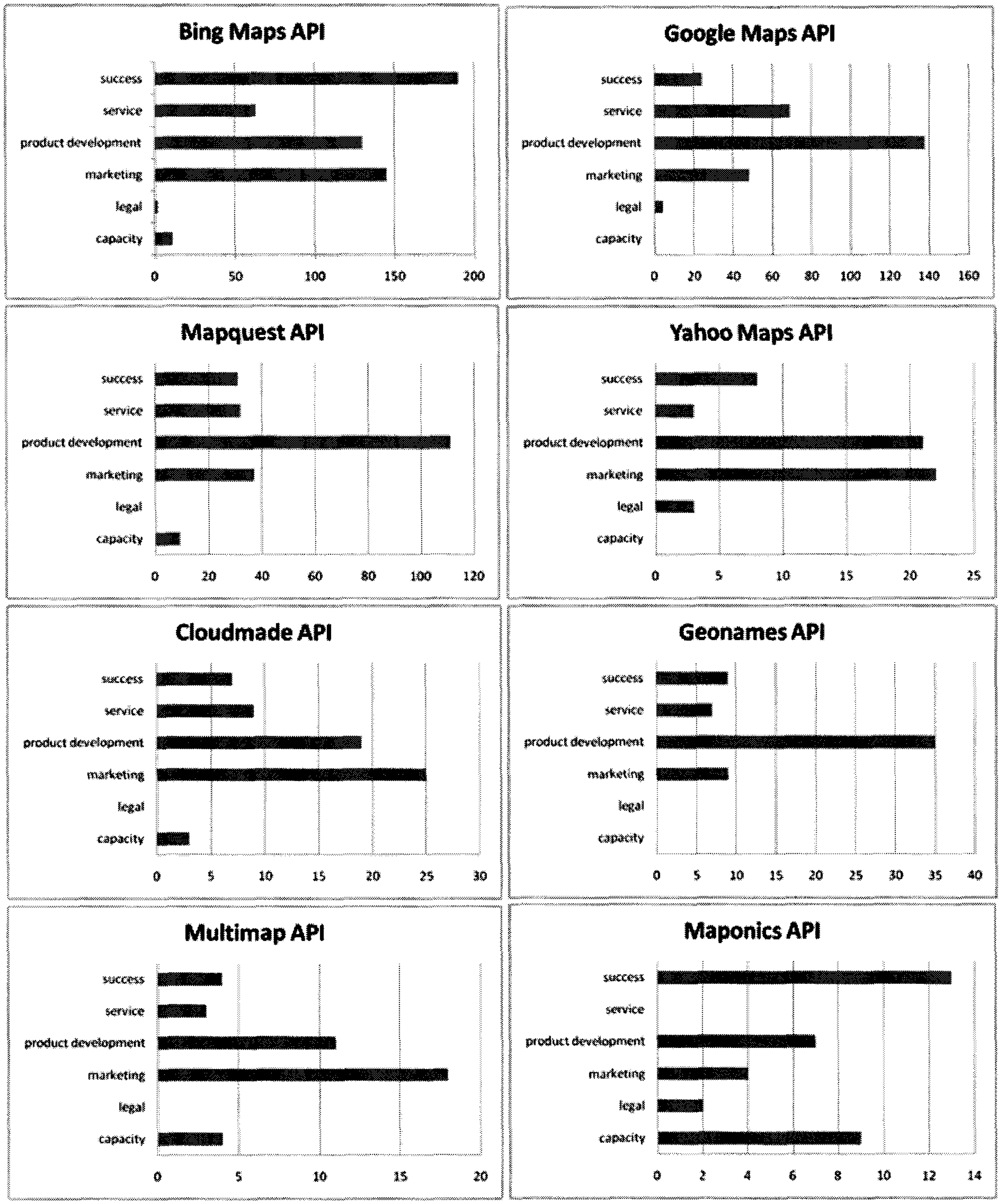

Figure 4: Competitive action distributions across 6 categories

The above distributions span the final six competitive action categories used in hypothesis testing. However, as mentioned above the original 16 categories comprise actions that are seemingly unique to the mapping APIs and perhaps also to the blog style data sources. Examining the distributions of the 16 categories provides additional insight into the characteristics of competitive actions taken by the 8 mapping APIs. The following table outlines the distributions of competitive actions across the 8 APIs, at the granularity level of the original 16 action categories. The top four highest volume categories for each API are bolded and highlighted.

Table 9: Percentage distributions of competitive actions across 16 categories

Categories	Original 16 categories	Google Maps	Bing Maps	Map-quest	Cloud-made	Multi-map	Geo-names	Maponics	Yahoo Maps
Product develop-ment	Feature enhancement	**37.27**	**18.67**	**41.12**	**20.63**	**15**	**45**	**17.14**	**21.05**
	New product	8.18	2.22	8.12	9.52	2.5	**10**	2.86	**14.03**
	Geographical expansion	0.45	2.77	0.51	0	10	3.33	0	3.51
	New platform support	4.55	0.74	4.06	0	0	0	0	0
Marketing	Marketing	**13.64**	**23.48**	**13.71**	**12.70**	**32.5**	**10**	2.86	**36.84**
	Engaging the community	3.18	3.14	3.55	**25.40**	**12.5**	5	**8.57**	1.75
	Earning opportunity	0	0.18	0	1.59	0	0	0	0
Success	Mashup spotlight	**13.18**	**32.90**	**10.66**	**11.11**	**7.5**	**15**	**37.14**	**14.04**
	Mashup spotlight current event	0.91	2.22	1.02	0	2.5	0	0	0
Service	Service disruption announcement	0	0.18	0	1.59	5	3.33	0	1.75
	Instructional	**14.55**	**10.54**	**16.24**	**11.11**	2.5	6.67	0	1.75
	Certification program launch	0	0.18	0	0	0	0	0	0
	Developer tool launch	0	0.74	0	1.59	0	1.67	0	0
Legal	Legal – TOS update	0	0.37	0	0	0	0	5.71	5.26
Capacity	Partnership	4.09	1.66	1.02	0	5	0	**20**	0
	Acquisition	0	0	0	4.76	5	0	5.71	0

5.2 Hypothesis testing results

The following section outlines the results obtained from hypothesis testing.

5.2.1 Variable calculations – Hypothesis 1

The following table outlines the calculated values for action pattern similarity and structural similarity for each mapping API pair. This data was used as input for testing Hypothesis 1.

Table 10: Action pattern similarities and structural similarities

Mapping API pair	Action Pattern Similarity	Structural Similarity
Geonames-Maponics	0.014349215	2.677171527
Geonames-Multimap	0.012643308	2.632217968
Geonames-Cloudmade	0.012602431	2.601929062
Cloudmade-Multimap	0.011758949	0.138433244
Bing-Google	0.005950208	9.900198851
Bing-Mapquest	0.007149603	1.906800593
Bing-Yahoo	0.010034625	1.906800593
Bing-Cloudmade	0.008843523	1.839841684
Bing-Multimap	0.009530336	1.863831429
Bing-Maponics	0.01071062	1.907714031
Bing-Geonames	0.009937887	1.409895343
Google-Mapquest	0.007492886	10.57007478
Google-Yahoo	0.009997182	10.57007478
Google-Cloudmade	0.009234976	10.55622082
Google-Multimap	0.00992658	10.56455186
Google-Maponics	0.011844901	10.57435923
Google-Geonames	0.008474255	9.817409694
Mapquest-Yahoo	0.011380304	0
Mapquest-Cloudmade	0.009473386	0.186663348
Mapquest-Multimap	0.011319395	0.138433244
Mapquest-Maponics	0.012559894	0.118056267
Mapquest-Geonames	0.01146303	2.675218575
Yahoo-Cloudmade	0.010868161	0.186663348
Yahoo-Multimap	0.012620801	0.138433244
Yahoo-Maponics	0.013609343	0.118056267
Yahoo-Geonames	0.013061177	2.675218575
Cloudmade-Maponics	0.012903898	0.144588808
Multimap-Maponics	0.014059302	0.072294404

The figure below indicates a scatter plot of these two variables.

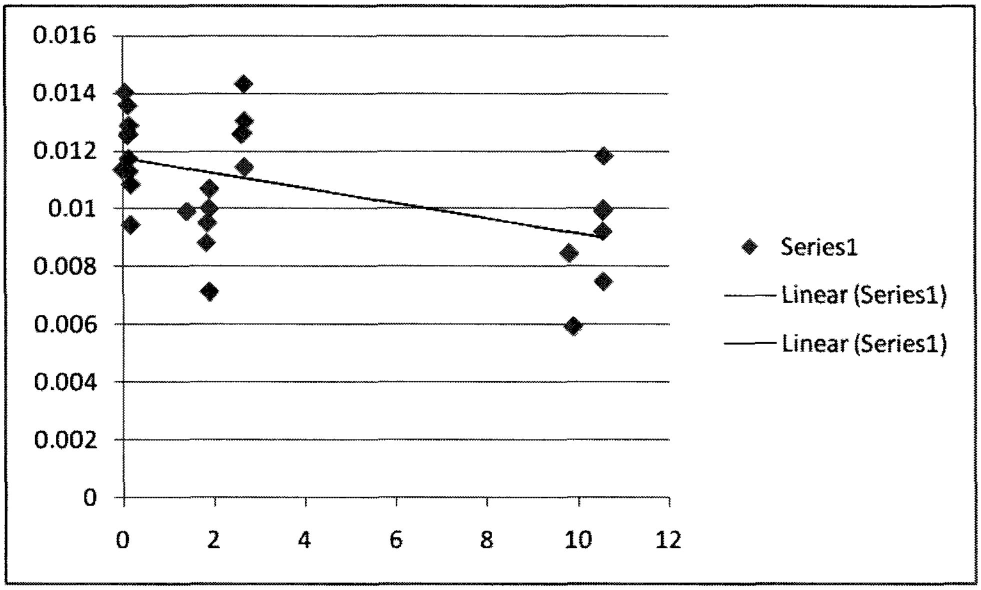

Figure 5. Scatter plot of pair-level variables

5.2.2 Variable calculations – Hypotheses 2, 3 and 4

The following table outlines the calculated firm-level constructs for each mapping API. This data was used as input for testing Hypotheses 2, 3 and 4.

Table 11: Summary of firm-level variable values

API	Action volume	Complexity-of-action repertoire	Action hetero-geneity	Degree centrality	Normalized betweenness centrality	Eigen-vector centrality
BingMaps	541	1.408722	2.3663156	98	1.923781	0.065339
GoogleMap	283	1.255869	1.1992856	286	18.67925	0.128325
Mapquest	197	1.215749	1.1582694	5	0.030481	0.001945
YahooMaps	57	1.276997	0.7162204	75	2.042132	0.052514
Maponics	35	1.378999	0.7205976	0	0	0
Multimap	40	1.306636	0.7051584	3	0	0.003125
Geonames	60	1.092535	0.7552229	85	0.713848	0.057636
Cloudmade	63	1.355699	0.6602481	6	0.002453	0.004948

5.3 Correlations and regression analysis

The hypotheses were tested for association between variables using correlation functions in R statistical software. A linear regression was also performed to explore causal effects between the variables.

In the tables and figures below, significance at the 0.05 level is marked with one asterisk (*) and significance at the 0.01 level is marked with two asterisks (**).

Table 12: Pearson product-moment correlations for all variables

	Structural Similarity	Degree centrality	Betweenness centrality	Eigenvector centrality	Action volume	Action hetero-geneity
Action pattern similarity	-0.50914 ** (0.00565)					
Degree centrality		1				
Betweenness centrality		0.9462838 ** (0.0003720)	1			
Eigenvector centrality		0.9760373 ** (3.378e-05)	0.855492 ** (0.00675)	1		
Action volume		0.4489389 (0.2645)	0.3350749 (0.4172)	0.4910892 (0.2165)	1	
Action heterogeneity		0.3184109 (0.4421)	0.1795292 (0.6705)	0.3853242 (0.3458)	0.982498 ** (1.323e-05)	1
Complexity-of-action repertoire		0.0040277 (0.9924)	0.07387026 (0.862)	-0.03159351 (0.9408)	0.3152743 (0.4469)	0.3517851 (0.3928)

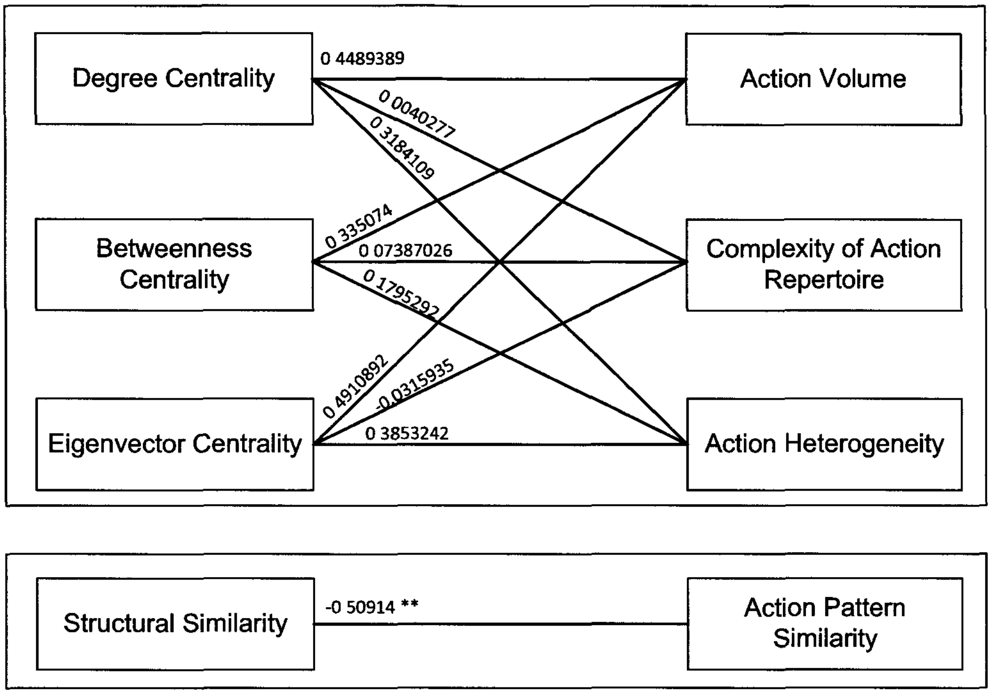

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Figure 6: Pearson product-moment correlations for H1, H2, H3 and H4

There is a highly significant negative correlation between structural similarity and action pattern similarity. This negative relationship does not support Hypothesis 1.

None of the variables action volume, action heterogeneity, and complexity-of-action repertoire were significantly individually associated with degree centrality, betweenness centrality or eigenvector centrality respectively. These results fail to support Hypotheses 2, 3 and 4.

5.3.1 Linear and multiple regression

The following tables indicate results of linear regression on each variable and combinations of variables. The values consist of the coefficient of determination (R-squared) value with significance in brackets. Each model below represents a different combination of independent variables (degree centrality, betweenness centrality and eigenvector centrality) with each of the three dependent variables (action volume, complexity-of-action repertoire and action heterogeneity).

The following acronyms are used in the table below:

- AV = action volume
- COA = complexity-of-action repertoire
- AH = action heterogeneity
- DC = degree centrality
- BC = betweenness centrality
- EC = eigenvector centrality
- SS = structural similarity

Table 13: Linear and multiple regression results

Models	R-squared (significance)	Slopes
Model 1: Action pattern similarity as regression of structural similarity	**0.2592 ** (0.005656)**	SS: -2.609e-04
Model 2a: AV as regression of DC	0.2015 (0.2645)	DC: 0.8306
Model 2b: COA as regression of DC	1.622e-05 (0.9924)	DC: 4.788e-06
Model 2c: AH as regression of DC	0.1014 (0.4421)	DC: 0.001507
Model 3a: AV as regression of BC	0.1123 (0.4172)	BC: 9.328
Model 3b: COA as regression of BC	0.005457 (0.862)	BC: 0.001321
Model 3c: AH as regression of BC	0.03223 (0.6705)	BC: 0.01278
Model 4a: AV as regression of EC	0.2412 (0.2165)	EC: 1926.86
Model 4b: COA as regression of EC	0.0009981 (0.9408)	EC: -0.07964
Model 4c: AH as regression of EC	0.1485 (0.3458)	EC: 3.8672
Model 5a: AV as regression of DC, BC, EC	0.289 (0.6789)	DC: 0.01890 BC: -0.15790 EC: -16.21556
Model 5b: COA as regression of DC, BC, EC	0.08145 (0.9447)	DC: -0.007199 BC: 0.051688 EC: 8.588690
Model 5c: AH as regression of DC, BC, EC	0.251 (0.733)	DC: 0.01890 BC: -0.15790 EC: -16.21556
Model 6a: AV as regression of DC, BC	0.2786 (0.442)	DC: 2.334 BC: -23.898
Model 6b: COA as regression of DC, BC	0.04696 (0.8867)	DC: -0.000749 BC: 0.011985
Model 6c: AH as regression of DC, BC	0.2432 (0.4982)	DC: 0.006724 BC: -0.082943
Model 7a: AV as regression of BC, EC	0.2681 (0.4582)	EC: 2991.53 BC: -8.83
Model 7b: COA as regression of BC, EC	0.03897 (0.9054)	EC: -0.89114 BC: 0.00673
Model 7c: AH as regression of BC, EC	0.2325 (0.516)	EC: 8.67390 BC: -0.03986
Model 8a: AV as regression of DC, EC	0.2607 (0.47)	DC: -1.187 EC: 4384.097
Model 8b: COA as regression of DC, EC	0.02667 (0.9347)	DC: 0.0008752 EC: -1.8912010
Model 8c: AH as regression of DC, EC	0.2187 (0.5395)	DC: -0.005765 EC: 15.799595

A statistically significant explanatory model was found between action pattern similarity and structural similarity.

When the individual dependent variables (action volume, action heterogeneity and complexity-of-action repertoire) were regressed against the independent variables (degree centrality, betweenness centrality and eigenvector centrality), none of the relationships were statistically significant.

When multiple regression was used between a combination of the independent variables and each dependent variable, none of the relationships were statistically significant.

However, Model 4a indicates a p-value that is relatively close to 0.10. While this is not considered statistically significant, it does indicate some relationship between action volume and eigenvector centrality. The figure below plots this positive relationship.

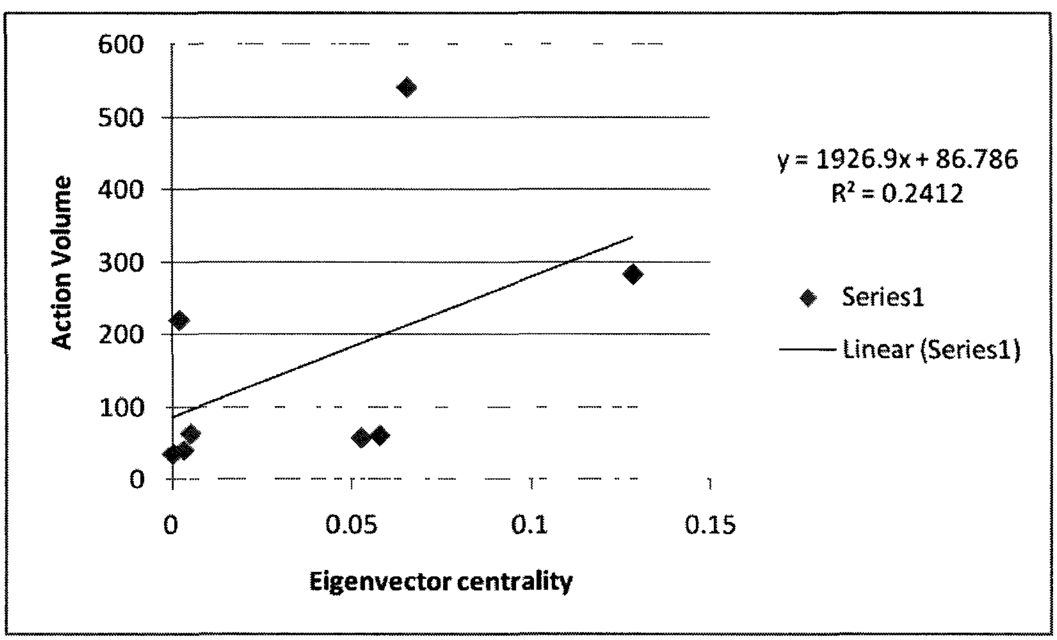

Figure 7. Scatter plot of action volume and eigenvector centrality

6 DISCUSSION

This chapter is organized into the following sections. The first two sections discuss the hypothesis testing results and the third section discusses the competitive action distributions.

6.1 Hypothesis 1 negative correlation

The highly significant negative correlation between structural similarity and action pattern similarity was not expected. In an interfirm network a positive correlation is expected, as structurally similar firms occupy similar resource positions in a network and interact with similar others in similar ways; these firms will tend to have similar attitudes and access to resources, and often imitate each other (Gnyawali & Madhavan, 2001). This study predicted that the resource flows specific to the mashup ecosystem would yield similar results.

One possible explanation is that structurally different APIs are competing in different communities within the mashup ecosystem; that is, they are combined with distinct groups of APIs. The mapping APIs examined in this research offer similar functionality; within distinct communities they have more opportunity to gain mashup market share as a result of less competition. These network positions are mutually reinforcing as experience is built around these specific API combinations (Weiss & Gangadharan, 2010) and may lead to similar behaviour between APIs within two different network communities.

Further to that, the complexities of imitation and innovation may be a contributing factor. While structurally similar firms often imitate each other (Gnyawali & Madhavan, 2001), in the context of modularization, performance gains from innovation are threatened by imitation (Ethiraj, Levinthal, & Roy, 2008). Additionally, market share gains increase when top firms seek a unique approach to their diversity of product offerings, technological leadership and branding (Ferrier, Smith, & Grimm, 1999). As such, API providers who find their APIs competing with similar APIs for mashup market share in combination with the same other APIs may increase their efforts to differentiate themselves in competitive strategy, especially to deter imitation.

Finally, this research did not account for the resources available to an API at the API provider level. While each API provider in the research population only offers one mapping API, some providers such as Google offer many other APIs as well, and this impact was not considered in this research. Moreover, an API provider such as Google may be able to produce many more feature enhancements due to key interfirm partnerships, market influence and sheer volume of manpower. In contrast, Multimap has a smaller mashup market share and lower action volume; however, Multimap was acquired by Microsoft in 2007 and thus inherits the greater resources afforded by Microsoft. Controlling for these complexities may reveal further the nature of the relationship between structural similarity and action pattern similarity in the mashup ecosystem.

6.2 No relationships between firm-level measures

For the dataset used in this research, no significant correlation was found between action volume, complexity-of-action repertoire, and action heterogeneity, and any of the three firm-level structural measures (degree centrality, betweenness centrality, and eigenvector centrality). This result does not support the hypotheses that network structural position within the mashup ecosystem influences competitive action.

A possible explanation is that the centrality measurements are not adequate proxies for access to status, innovation and experience flow. The nature of the mashup ecosystem wherein growth occurs via mashup developers' independent choices stands in sharp contrast to the interfirm network as a "strategic resource that managers design and develop over time in order to meet their objectives" (Madhavan, Koka, & Prescott, 1998). It is possible that the accepted theory that organizational actions are embedded in networks of relationships (Gnyawali & Madhavan, 2001) cannot be directly extended to the mashup ecosystem.

As such, competitive actions taken by API providers may not be as strongly shaped by resource flows within the mashup ecosystem as by resource flows available directly to an API provider via strategic alliances. Further to that, API providers may simply not give much regard to developer activities and existing mashups (as part of experience and innovation flow) in developing their competitive strategies, though the competitive actions indicate significant efforts to engage mashup developers and promote their work.

6.3 Competitive action categories

Within the distributions of competitive actions, two action categories were universally dominant - feature enhancement and mashup spotlight. While feature enhancement can be considered an established category in competitive strategy theory (Ferrier, 2001) – that is, corresponding to the *product* category, the mashup spotlight category is unique to the context of this research. This indicates API providers are making efforts to promote the work of developers using their API – a testament to the increasing importance of product and service development by users (von Hippel, 2004).

The three oldest and most popular APIs in the research population, according to ProgrammableWeb, are Yahoo Maps, Google Maps and Bing Maps (the definition of "oldest" referring to when the API was first added to the ProgrammableWeb database).

These three APIs were consistent in their top four categories within the distribution: marketing, mashup spotlight, feature enhancement and instructional. This is an interesting observation about the consistency of behaviour of major players in the mashup ecosystem, but may also be indicative of the relative vast resources available to the API providers of these three APIs - Yahoo, Google and Microsoft which are all large corporations.

While marketing and feature enhancement correspond to established categories (Ferrier, 2001), the mashup spotlight and instructional categories emphasize service to the developer community. This again emphasizes a commitment to supporting user innovation displayed by the major players in the mashup ecosystem.

Lastly, the newest and least popular APIs within the research population were Cloudmade, Multimap and Maponics. It is interesting to note that their API providers universally focused more on engaging the community and less on providing instructional services to developers. This may indicate that resources may be more focused on promotion and growth for new entrants to the mashup ecosystem, and may also imply a lifecycle model where entrant behaviour evolves into incumbent behaviour. While a link between competitive action and market share has not been empirically explored in this context, these less popular APIs may also benefit from emulating the major players by providing all-round service to the developer community.

7 CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

This chapter is organized into the following sections. The first section describes the conclusions. The second section outlines the contributions. The third and fourth sections discuss limitations and future research.

7.1 Conclusions

This thesis attempts to answer two research questions:

(i) What competitive actions are taken by API providers within the mashup ecosystem?

(ii) Is there a link between competitive action sequences and API affiliate network structure?

Based on the results of the research, the following conclusions can be drawn:

- API providers perform competitive actions that fall into the following six categories: marketing, product development, service, legal, capacity and success. These categories represent a modification to earlier categories established by (Chi, Holsapple, & Srinivasan, 2007) and (Ferrier, 2001).

- API providers place a strong emphasis on frequent feature enhancements and promotion of third-party developer mashups in their competitive strategies, demonstrating their commitment to and the importance of user innovation. New entrants to the mashup ecosystem may gain an advantage in emulating incumbents by focusing on service to developers.

- A highly significant negative relationship was found between action pattern similarity and structural similarity in the API affiliate network. This result may be attributed to the existence of distinct communities of competitive dominance within the mashup ecosystem, and a motivation to differentiate competitive strategy when competing within the same community.

- No significant relationship was found between the firm-level measures of action volume, complexity-of-action repertoire, and action heterogeneity, and degree centrality, betweenness centrality and eigenvector centrality. This may indicate that structural embeddedness theory (Gnyawali & Madhavan, 2001) cannot be directly extended to the mashup ecosystem, and that the centrality measurements are not adequate proxies for access to status, innovation and experience flow.

7.2 Contributions

This study makes at least four contributions.

7.2.1 Extension to competitive dynamics research

By empirically analyzing the relationships between the API affiliate network structure and competitive actions, this study offers new tools, methods and insights to established competitive dynamics research in a unique, cutting-edge, web-based industry environment where competitors are also complementors and where user innovation plays a strong role. This is a particular departure from established research which does not consider competitors as also having a complementary or collaborative relationship with each other.

7.2.2 Categorization of competitive actions at API level

This research offers a categorization of competitive actions of API providers in the mashup ecosystem; more specifically, the categorization was filtered to represent competitive actions at the API level of analysis in order to explore a relationship to API affiliate network structure. These competitive action categories represent a notable departure from those collected for more established and non-web-based industries, and the deeper level of analysis goes beyond the firm level traditionally used in competitive dynamics research.

7.2.3 Influence of mashup ecosystem network position

This study contributes an extension to the theoretical integration of social network analysis and competitive dynamics seen in (Chi, Holsapple, & Srinivasan, 2007). Specifically, relationships were found between network structural position and competitive action patterns indicating that a broader popularity within the mashup ecosystem may enable or drive an increased volume of competitive actions, and that APIs combined often with the same other APIs display very different competitive action patterns.

7.2.4 Managerial implications

Firstly, API providers may benefit from the lifecycle implied in competitive action patterns observed in this study; they can emulate incumbents in the mashup ecosystem by focusing their competitive strategies on frequent feature enhancements and active engagement with the developer community in the form of providing instructional assistance and celebrating and promoting developers' mashup achievements.

Secondly, (Weiss & Gangadharan, 2010) advocated that as the network positions of API providers are mutually reinforcing, API providers should ensure their API integrates well with other well-positioned APIs and look for opportunities to complement existing APIs. In extension, this research suggests that in promoting integration with key other APIs, API providers can endeavour to dominate a community of key API combinations increasing in popularity and accumulated developer experience. In doing so, API providers would also benefit from a deeper understanding of the mashup ecosystem network structure, as advocated for other network contexts by (Weiss & Gangadharan, 2010; Chi, Holsapple, & Srinivasan, 2007; Gnyawali & Madhavan, 2001).

Thirdly, APIs combined often with the same other APIs were observed to have very different competitive action patterns month-by-month. Established research indicates that market share gains increase when top firms seek a unique approach to their diversity of product offerings, technological leadership and branding (Ferrier, Smith, & Grimm, 1999), and API providers may be well-served to diversify their competitive strategies especially when faced with close competition for mashup market share.

Finally, the possible relationship between the volume of competitive actions taken and the diversity of combination with other APIs may indicate that a broader popularity within the mashup ecosystem may enable or drive increased competitive actions. This suggests API providers may benefit from nurturing mashup combinations with many different other APIs.

7.3 Limitations

This research has several limitations that could be addressed in future research.

- The results rely on the researcher's interpretation of blog articles as competitive actions.

- This research used publicly available blog articles as sources of competitive actions. Blog articles differ from sanctioned news releases in that a certain informality and subjectivity may exist in reported activities and announcements.

Additionally, API provider representatives were not interviewed and thus motivations behind competitive actions were not examined.

7.4 Future Research

There are six key areas of opportunity for future research.

1) Future research could further investigate competitive dynamics in the mashup ecosystem by examining distributions of competitive actions over time to investigate whether certain actions are particular to specific API segments defined by API provider size, age, or category; and by examining how competitors in the mashup ecosystem respond and react to each other at the more granular action-reaction dyad level.

2) This research could be extended by repeating the research method with a wider number and variety of APIs beyond the mapping category, and determining whether additional competitive action categories can be identified for the mashup ecosystem.

3) This study put forth a suggestion that resource flows in the mashup ecosystem consist of experience, status and innovation flow. Future research could explore the validity of this concept and how it might tie back to structural embeddedness theory established by (Gnyawali & Madhavan, 2001).

4) Building on previous study of the evolution of the API affiliate network (Weiss & Gangadharan, 2010; Yu & Woodard, 2009), future research could examine the co-evolution of network structure and competitive actions within the mashup

ecosystem. This could be achieved through the use of longitudinal and process-based techniques on action sequences, and more sophisticated social network analysis techniques that can identify key players and clusters in the network.

5) Previous studies in competitive dynamics, as well as this research, looked at characteristics of competitive actions as *aggregation measurements* over periods of time; for example, action volume, action heterogeneity and complexity-of-action repertoire. Additionally, the Euclidean distance measurement used in this research does not take into account the sequence of individual events; just the aggregation of events at the month level. In the study of animal behaviour, sequential analysis is used to examine action sequences and to generate transition probabilities. This takes into account order of actions, offers a novel way of characterizing action sequences and offers a predictive model as well. A tool such as JWatcher (Blumstein & Daniel, 2007) could be used to perform sequential analysis on the competitive action sequences collected in this study.

6) Finally, this research process could be repeated on another network involving co-opetitive platforms and external contributors, to explore whether a general pattern of competitive actions exists and whether the results of this study are more broadly applicable. An example might be an open source ecosystem, such as Eclipse; such research could build on existing explorations of competitive actions taken by open source firms.

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9 APPENDIX A – SAMPLE CATEGORIZATION

The following table indicates a sample of blog articles and their categorization.

Table 14: Sample of blog article categorization

Date	Blog article title	API	Category
14/06/2006	Yahoo! Maps? You Don't Have to Ask.	Yahoo Maps	legal
01/10/2006	One million web service queries per day	Geonames	marketing
14/02/2007	Active Hotels implements Multimap's API service.	Multimap	success
10/05/2007	Virtual Earth @ Where 2.0	Bing Maps	marketing
29/05/2007	Driving Directions Support Added to the Google Maps API	Google Maps	product development
21/08/2007	Virtual Earth Imagery Update - August 2007	Bing Maps	product development
09/11/2007	Cumul.us Lets You Predict Weather	Geonames	success
12/12/2007	Microsoft Acquires Multimap	Bing Maps	capacity
26/02/2008	Custom Mouse Events to Data Overlays	Mapquest	service
06/03/2008	Creating Points of Interest with Flex and the MapQuest 5.2 APIs	Mapquest	service
09/07/2008	Change Virtual Earth Background Color	Bing Maps	service
24/10/2008	Google Maps API Gets Reverse Geocoding	Google Maps	product development
26/11/2008	Update to the Google Maps API Terms of Service	Google Maps	legal
28/01/2009	geekSpeak Webcast: Virtual Earth for Developers (Level 200)	Bing Maps	marketing
25/02/2009	Yahoo! Maps - Enhanced International Support!	Yahoo Maps	product development
12/05/2009	Shall We Play A Game? UMapper's Virtual Earth Game	Bing Maps	success
10/06/2009	Goodbye Virtual Earth, Hello Bing Maps	Bing Maps	marketing
23/07/2009	Hillary Clinton Uses Google Maps API	Google Maps	marketing
01/09/2009	New Articles: Powering Maps API v3 Apps with MySQL	Google Maps	service
15/09/2009	DexKnows.com Chooses Maponics Neighborhood Database for Local Search by Neighborhood	Maponics	success
08/10/2009	New geocoding engine delivers results up to 24 times faster	Cloudmade	product development
09/11/2009	Bing Maps Terms Of Use Changes; Benefit Educators, Not-For-Profits And Developers	Bing Maps	legal
09/11/2009	Maponics CEO to Present at PubCon 2009	Maponics	marketing
03/12/2009	Microsoft Partners with Navteq for Streetside Photos	Bing Maps	capacity
15/01/2010	Tweet12k Chooses Yahoo Maps To Show Geo Tweets	Yahoo Maps	success

10 APPENDIX B: SAMPLE BLOG POSTS

10.1 Sample post for "service" category

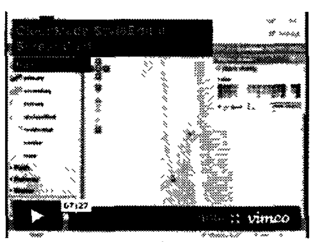
Introducing the CloudMade Developer Zone

The CloudMade Developer Zone launched last week in San Francisco. We'll be bring the launch to London this Thursday February 12th. There will be keynotes, live demonstrations from CloudMade partners that will include social networking, navigation, real estate, personal tracking, fleet tracking applications and more. There are only a few places left, so please sign-up now to avoid disappointment.

The CloudMade Developer Zone has all the resources developers need to get started building awesome location based applications. Here are some highlights:

Video Tutorials

Video tutorials are a great way to get started with a new tool quickly. We're going to be publishing lots more screen casts, like this one about our Style Editor:



If you've been using any of our tools or APIs, you can create a screen cast and have it featured on the site. You could show how to make an amazing map style using the Style Editor, how to take our Ruby API and integrate it into a Rails application or how to use our open source repositories to modify our iPhone Maps Library. Email in your screen casts here and we'll get back to you.

Open Source Libraries and APIs

We want to make it as easy as possible for you to get started using our services. So that you can be up and running with as little hassle as possible, we have open source libraries for Ruby, Java, Python and iPhone Objective-C. From the Developer Zone you can browse and check-out the source code, join the project and contribute back to the community. There's also step-by-step tutorials for each library and wiki pages where you can add any tips you might have.

You can find out more about the Developer Zone here.

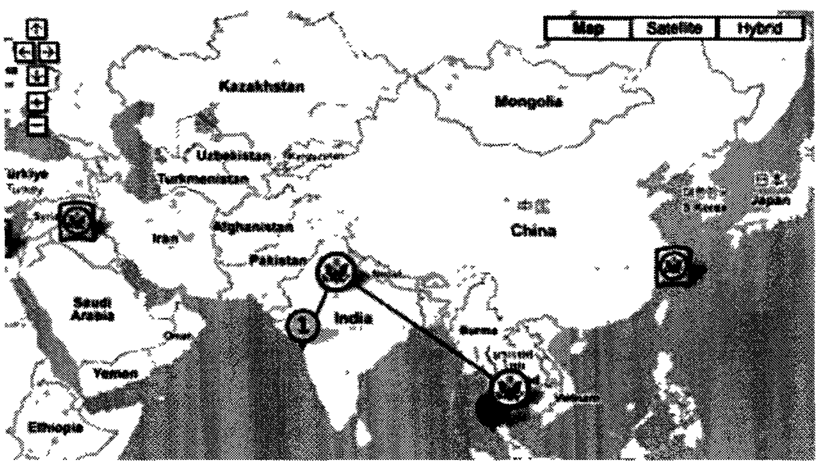
10.2 Sample post for “marketing” category

Hillary Clinton Uses Google Maps API

Adam DuVander, **July 23rd, 2009**

The US government isn’t just opening its data, it’s now creating mashups. The Department of State is tracking Secratary Hillary Clinton’s world travel using the Google Maps API.

Clinton’s current location and the path of the trip is marked with the department’s seal, while previous stops are surrounded by a grey box. Click a marker and you’ll get individual stops on a trip. Each stop contains a summary, remarks from the Secretary and photos of the stop from the department’s Flickr account.



Anyone really think Hillary Clinton is sticking her fingers into APIs? It appears unlikely even that her staff created the maps. The feature is hosted in an iframe by a Virginia software development firm.

10.3 Sample post for "capacity" category

Microsoft Partners With Navteq For Streetside Photos

December 03, 2009, 09:00 AM by Chris Pendleton | 5 Comments

By now you've noticed our latest release of Bing Maps which includes Streetside photography (read, Bing Maps Adds Streetside, Enhanced Bird's Eye, Photosynth and More). Now, you may be wondering, "You don't have coverage in my area. When will you have pictures of my house?" OMG – go outside, stand in the middle of the street and BOOM there's your house. Kidding. Seriously, we have some massive expansion plans to include all of the areas where we don't currently have in Streetside and they now include one of our providers of that sacred road data – Navteq. You see, while Navteq is out there collecting the best of breed road information inclusive of speed limits, bridge heights, turn restrictions, one way streets (you know, important information so you don't get killed navigating with their data) we figured it prudent to strap a few cameras on their vehicles to record some photos. How's that for scaling out? Plus, we'll be doing monthly releases of Streetside photos similar to how we process and release monthly aerial photos and satellite imagery. And, what better camera technology to use than the Microsoft Vexcel UltraCam technology? Well, there isn't one – it's the best on the market. And, now, Navteq has them in a *"new technology partnership between the two companies…to mutually invest in the development of advanced collection capabilities that will accelerate the collection, creation and storage of 3D map data and visuals."*

10.4 Sample post for "product development" category

Announcing Google Maps API v3

Wednesday, May 27, 2009

Since our last major release of the JavaScript Maps API three years ago we've been delivering feature requests that all of you have been asking for month over month. With over 150,000 active websites implementing it, the Maps API has become one of the most popular and trusted developer tools on the web. We're in the process of giving the Maps API a major facelift and today we're providing you a look at V3 in our Google Code Labs.

The primary motivation behind this new version was speed, especially for rendering maps on mobile browsers. Last year, several of us starting thinking about the possibility of getting the JavaScript Maps API to work on mobile devices. With the advent of powerful, fully functional browsers on devices such as the iPhone and the Android-based G1, why couldn't we bring the flexibility and reach of modern web development to people who wanted to write maps mashups for mobile phones? While we've been able to get the existing v2 API working on mobile browsers, we found we were constrained when trying to reduce latency and we needed a new approach. And thus was born the idea for the next revision of the Maps API.

We wanted to get this in your hands as soon as possible, so we've intentionally released it early, and with a basic set of features. We're releasing it in Labs because it's not fully baked yet; we want to get your feedback on the new design and what you'd like to see in future revisions now that we have a chance for a fresh start. Yes, this does mean that you'll have to rewrite your existing mashup code if you want to take advantage of v3, but we think that speed is very important to a great user experience.

What's changed in v3? Besides the substantial improvements in speed, a few other things that you'll notice in the initial release:

- iPhone Safari mobile and Chrome added to our supported browsers. Your mashups will also work on Android-based phones with the recent update, but you may notice some issues, like the "View/Save Image" dialog showing unexpectedly. We're working with the Android team to fix this and improve the end user's experience in interacting with the map. We could've waited until it's perfect, but we really wanted to get an early release in your hands and start getting feedback while we fix up a few remaining issues.
- No keys required. You can now copy 'n paste code easily or embed in RSS readers, for example, without getting key errors.
- MVC-based architecture. This allowed us to significantly reduce the size of our initial JavaScript download. We found it to be simple and powerful.
- Default UI is enabled automatically. We'll provide default UI controls and behavior (and we'll update them) so your mashup can keep up with the latest and greatest changes we make to Google Maps. Of course, if you've got customized controls you're happy with, you can disable the default UI updates.
- Namespaces. Everything is always in the google.maps.* namespace and there is no "G" prefixed variables in the global scope.
- Geocoding API has been overhauled based on the feedback we've received with the existing implementation over the past three years.

Check out the reference and documentation for more details.

What does the API look like? Here's a quick, complete example that you can grab to render a map. It's even set up to render a full-screen interactive map on the iPhone and Android browsers.

```
<html>
<head>
<meta name="viewport" content="initial-scale=1.0, user-scalable=no">
<script type="text/javascript"
src="http://maps.google.com/maps/api/js?sensor=false"></script>
<script type="text/javascript">
  function initialize() {
    var latlng = new google.maps.LatLng(-34.397, 150.644);
```

```
    var myOptions = {
      zoom: 8,
      center: latlng,
      mapTypeId: google.maps.MapTypeId.ROADMAP
    };
    var map = new google.maps.Map(document.getElementById("map_canvas"),
myOptions);
  }
</script>
</head>
<body onload="initialize()">
 <div id="map_canvas" style="width:100%; height:100%">
</body>
</html>
```

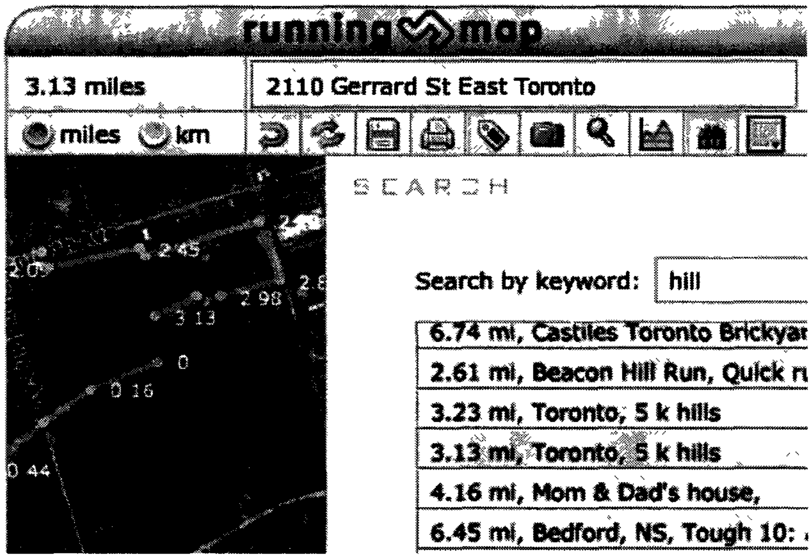
We've set up a new group for you to provide feedback. Also, the terms have been updated to remind you that versions we release as "experimental" or in Labs may not have the same level of support as ones that are already out of Labs. This means that we'll continue to support the current v2 API well after v3 matures and graduates from Labs. In the meantime, we're looking forward to adding a lot more functionality to this new release so please send us your feedback!

Posted by Mickey Kataria, Product Manager

10.5 Sample post for "success" category

Developer Spotlight: RunningMap.com
Tue July 31, 2007

by Kent Brewster (@kentbrew)
Randy Troppmann (with designer/developer Sarah Ramsden) reports continued success with the Yahoo! Maps and Flickr APIs on RunningMap.com. Visitors can create, edit, save, share, and add Flickr photos to maps of their favorite running routes. Or, if you've forgotten your permalink, you can search over 13,000 user-generated routes.



RunningMap is quick, easy to use, and does just the sort of thing we were hoping for when we started opening up the APIs: it meets an ongoing need that could only be expressed and fulfilled by a committed online community. Congratulations, folks; we'll see you on the road.

Kent Brewster, Yahoo! Developer Network

10.6 Sample post for “legal” category

Update to the Google Maps API Terms of Service

Wednesday, November 26, 2008

Posted by Mickey Kataria, Product Manager

From time to time we release updates to the terms of service governing our products. We recently released an updated version of the Google Maps API Terms of Service. Based on feedback from that update, we are releasing a revised version today. The Google Maps API TOS is intended to satisfy several goals: it gives Google the rights needed to operate a service which overlays content on the map, gives us the ability to showcase popular mashup sites, and allows us to index and provide search over Maps API sites so that Google users can find them.

What changed and why? A key goal for the November 12th revision was to eliminate a number of unpopular restrictions, including the prohibition on friend finder applications and non-"site" mashups. We also eliminated ambiguity about whether it's OK to use the API w/ password-protected free sites (it is). Additionally, we streamlined the format of the terms, eliminating the need for developers to reference multiple sets of incorporated terms of service, including the Google Terms of Service and the Google Maps Terms of Service to figure out what rights and obligations applied to their use of the Maps API.

That format change appears to have called attention to the "License From You to Google" - section 11 in the November 12th update. That content license has always been part of the Google Maps API Terms of Service, because it is contained in the Google Terms of Service. Both the original and the November 12th updated Terms of Service relied on that provision to ensure Google received a sufficient content license to provide the Maps API service and to promote the service, including by highlighting excellent mashups as we did here. That section does not provide Google a license to all of the content on your Maps API site to use for any purpose, nor is that how we have treated the content from existing Maps API sites that were developed under the terms that existed prior to the November 12th update. Section 11(b), which we initially included in the November 12th update, created a lot of confusion among our API developers who are publishing licensed content. In 11(b) we were trying to be clear that we wanted a broader license from Maps API developers for use of business listings information. However, given the confusion that resulted, we removed that language from today's revision of the terms.

Thank you for using the Google Maps API. We look forward to continuing to create great products together with you.

11 APPENDIX C: SAMPLE OF MASHUP-API DATABASE

The following table indicates a subset of the raw database collected from ProgrammableWeb in February 2010 and used to generate the API affiliate network used in this research.

Mashup name	APIs used
DoorFly.com Agent Notifications	Twilio
Mahen	Twitter
Task.fm	Twilio, GoogleTalk, GoogleCalendar, AIM
The American Civil War Timeline Project	GoogleMaps
V3GGIE - Vegetarian Search Engine	YahooBOSS, Flickr, Amazon
Shout Now	Twitter, Twilio, Facebook
unrut	Mapstraction, GoogleMaps, Nextstop, Yelp
Insider Food	YahooBOSS, Flickr, Amazon
Travelfusion Flight search	TravelFusion
tetonGeo	YouTube, Twitter, TownMeGeo, GoogleMaps, Foursquare, Flickr
Call My Team	Twilio
API status	WatchMouse, GoogleChart, AmazonS3, AmazonEC2
In Their Honour	GoogleMaps
Chitter.TV	Twitter
Parklnfo - Find Public Parks in California	GoogleMaps, GoogleEarth, BingMaps
Geo Talk	GoogleMaps, Disqus
Album art search	Amazon
MagenPro	Doba
geognos	Panoramio, GoogleVisualization, GoogleMaps, GoogleAppEngine, GoogleAJAXLanguage
Screamradius	YahooLocal, Wikipedia, Twitter, GoogleMaps
TripMixx	YouTube, Wikipedia, WeatherChannel, Upcoming, Kayak, GoogleMaps, GeoNames, Flickr
Alt What Now	Upcoming, Twitter, Layar, GoogleMaps, CareerBuilder
SvD weather	NorwayWeather, GoogleMaps, GeoNames
Mpire	eBay, Amazon, Shopping.com, YahooShopping

12 APPENDIX C: SUGGESTED KEYWORDS FOR AUTOMATION

This research used a manual content analysis technique to categorize blog postings. The following appendix suggests keywords for a future researcher interested in exploring the automation of the categorization process; blog postings could potentially be categorized by the presence of certain keywords in their content. However, context may still play an important role due to the informal nature of blog postings.

Table 15: Suggested keywords for automation

Refined categories	Suggested keywords
Product development - feature enhancement, new product, geographical expansion or new platform support	announcement, feature request, new release, new version, facelift, what's changed, what's new, update, revision, introduced
Marketing - any marketing activity (events, promotions), engagement of the developer community	events, conference, speaking, contest, webcast, session, hackathon, interview, nominated, campaign
Success - highlight or promotion of a mashup using provider's API	kudos, congratulations, integration, mashup, new application, launches
Service - tools, programs, announcements and documentation for developers	forum, documentation, user group, demonstration, tutorial, feedback, how to, bug fix, get started
Legal - Any litigation activities or updates to terms of service	terms of service, TOS, license, terms of use
Capacity - partnership or acquisition to increase output or service offerings	partners, acquires, new partnership, hiring