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**To cite this article:** Lara Khansa , Christopher W. Zobel & Guillermo Goicochea (2012) Creating a Taxonomy for Mobile Commerce Innovations Using Social Network and Cluster Analyses, International Journal of Electronic Commerce, 16:4, 19-52

**To link to this article:** <http://dx.doi.org/10.2753/IJEC1086-4415160402>



Published online: 08 Dec 2014.



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# Creating a Taxonomy for Mobile Commerce Innovations Using Social Network and Cluster Analyses

Lara Khansa, Christopher W. Zobel, and Guillermo Goicochea

**ABSTRACT:** Increasing numbers of people are spending time focused on “the third screen” of a mobile device. Through ubiquitous connectivity, personalization, and affordability, such mobile devices have become much more than just entertainment handsets. In particular, e-commerce has harnessed the power of wireless computing to expand to mobile commerce (m-commerce), thus providing consumers with commercial services on the go. Because such services are often driven by customer input, it is important to consider the relevance of consumers to the development of new service offerings. We therefore dissect innovations in m-commerce by conducting a textual analysis of all filed m-commerce patent applications (over 2,300 in total). By using social network analysis and cluster analysis, we subsequently capture the focal innovation areas in m-commerce and develop a corresponding taxonomy of these innovations. The results clearly illustrate the importance of consumer empowerment and co-creation in the context of m-commerce innovations.

**KEY WORDS AND PHRASES:** Cluster analysis, co-creation, empowerment, innovation, mobile commerce, social network analysis, taxonomy.

Mobile commerce, or m-commerce, is considered by many to be the next wave of electronic commerce (e-commerce) [44]. Because mobile devices such as cell phones, personal digital assistants (PDAs), and other handheld computers offer real-time communication and anytime-anywhere access, they can provide an important platform for such services as financial transactions (e.g., e-banking, buying, selling, payments, coupons), location-based queries (e.g., map services, traffic advisories), entertainment (e.g., gaming, ticketing), education, health care, inventory management and tracking, and even enterprise resource planning [25]. Skiba et al. captured this versatile nature of m-commerce by defining it as the “use of mobile devices to communicate, inform, transact” and entertain “using text and data via connection to public or private networks” [68, p. 8].

As with many other new technologies, the promise of m-commerce initially outpaced the actual delivery of m-commerce applications and services. As noted by Liang and Wei in their introduction to the 2004 special issue of the *International Journal of Electronic Commerce* on “Mobile Commerce Applications,” although m-commerce is “a promising technology for driving the second wave of e-commerce” [44, p. 15], “many attempts in m-commerce have so far failed to meet expectations” [44, p. 7]. Since that time, however, progress has been made toward fulfilling those early expectations. For example, more recent forecasts indicate that global retail m-commerce will reach \$119 billion per year by 2015 (the equivalent of 8 percent of the total e-commerce market) [66].

In 2003, Jarvenpaa et al. projected that “the success of m-commerce services is likely to depend on how flexible and malleable the technology is to all users to shape it to their individual and group needs in various social and business

contexts. It will be the innovativeness of users and uses, not the innovativeness of the technology, that will drive m-commerce growth to a new level" [31, p. 44]. Many other studies have also emphasized the role of the consumer in driving m-commerce innovation and in helping the m-commerce revolution to materialize [22, 50, 51, 59]. Mylonopoulos and Doukidis defined m-commerce as "an ecosystem of individuals and business actors, in given historical socioeconomic contexts, engaging in multiple successive technological frames through a learning process of co-creating new experiences of social interaction with the use of wireless and mobile technologies" [50, p. 8]. Indeed, one of the unique characteristics of mobile commerce is its ability to instill in consumers a much stronger feeling of empowerment [19] to co-create alongside producers than that provided by traditional e-commerce [83].

Our goal in this paper is to study the evolution of m-commerce innovations that have contributed to consumers' empowerment to adopt m-commerce and co-create alongside innovators. We thus leverage the power of social network analysis (SNA) and clustering techniques to uncover trends and similarities between innovations, as indicated by key words in the titles of U.S. patent applications related to m-commerce. While SNA has been used to build co-occurrence networks for paper citations as a way to synthesize prior literature [35, 42], we are not aware of any prior work that has applied the SNA methodology on patent titles to study the evolution and focal themes of patent topics and the related innovations.

With this in mind, the first step of our analysis uses an automated Web extractor to retrieve the text and details of more than 2,300 U.S. patent applications related to m-commerce from the years 2001 to 2010. Our approach then uses SNA to analyze the relationships between patent title key words and to capture the evolution of m-commerce innovations over time. Finally, we use cluster analysis to construct a high-level taxonomic framework for m-commerce innovations. It is important to recognize that although several other m-commerce-related taxonomies have been developed in prior research, they have tackled m-commerce applications [4, 41, 79] or m-commerce interface design [39] rather than m-commerce *innovations*. In contrast to these previous efforts, our taxonomy specifically highlights the value of m-commerce innovations in facilitating consumer empowerment and in enhancing co-creation between consumers and m-commerce innovators.

One of the major contributions of this research effort is to clearly point out the similarities and differences between e-commerce and m-commerce and to discuss how these differences characterize the role of consumer co-creation in m-commerce. Furthermore, the analysis of the evolution of m-commerce innovations developed below constitutes one of the first attempts to understand how m-commerce has matured over the years. As such, the discussion helps to illustrate the effect of evolving consumer needs on the filing of m-commerce patents by innovators. By highlighting the unique characteristics of m-commerce, the patent evolution map and the developed taxonomy also provide insights to practitioners on what they need to do to jump on the m-commerce bandwagon and be successful.

The remainder of this paper is organized as follows. We present in the following section a thorough review of related research on the importance

of consumer empowerment and co-creation in mobile commerce, along with the resulting “rationalization” of growth and innovation on the part of m-commerce firms. We then provide additional details about the data collection, data processing, and methods used in our study. This is followed by the results of our social network and cluster analyses, with particular emphasis on the maturing stages and evolution of m-commerce innovations. Subsequently, we present the new taxonomy of m-commerce innovations. In conclusion, we elaborate on the paper’s contributions and discuss the limitations of the study.

## Related Literature

Schumpeter [64] argued that technological change is the primary driver of innovation, and he assumed that consumers are able to absorb any new innovation, essentially suggesting that demand automatically adjusts to supply. In the 1960s, Schmookler [63] challenged Schumpeter’s theory by stressing the role of demand in inducing technical progress and arguing that the success of an innovation is intertwined with a strong and growing demand for it. With the advent of the Internet, cost-effective access to information has subsequently expanded the role of the customer from being a simple consumer to being both a creator of demand and a driver of innovation. Mobile devices have become an intrinsic part of their owners that accompany them at all times and provide them with anywhere-anytime real-time connectivity to the rest of the world. This has enhanced consumers’ empowerment and given them more opportunity and motivation to co-create value, so that this constant connectivity can be as meaningful as possible.

“Co-creation” is defined as “the participation of consumers along with producers in the creation of value in the marketplace” [83], and it can be either “autonomous” (voluntary) or “sponsored” (initiated at the request of a producer) [83]. Online systems such as wikis and blogs are good examples of co-creational applications in which users are the main providers of content. The related idea of “crowdsourcing” [16, 40] was born from consumers’ desire to contribute their opinions and ratings of products and services via established online review communities, such as Yelp. Crowdsourcing is also associated with the concept of “word of mouth” (WOM), which is defined as any form of “informal communications directed at other consumers about the ownership, usage, or characteristics of particular goods and services and/or their sellers” [78, p. 261].

WOM has been shown to significantly influence both sales and firm profitability. This influence is particularly significant for electronic WOM (eWOM), which uses the Web as its communication channel [83]. Chevalier and Mayzlin emphasized that eWOM has become “an important source of information to consumers, substituting and complementing other forms of business-to-consumer and offline WOM communication about product quality” [11, p. 345]. As an illustration of this, a recent study by Li and Hitt [43] revealed that the purchasing decisions of nearly 82 percent of consumers have been affected by online reviews. Furthermore, industry reports [17, 52] found eWOM more

effective than expert reviews at influencing offline and online purchasing behavior. Within m-commerce, as opposed to within the more general realm of e-commerce, it is significant that such reviews are available not only to consumers who are shopping online at home but also to those who are away from a computer and even those who are shopping at brick-and-mortar establishments. Consumers thus have the ability to augment their shopping experience, and that of other consumers, in real time and at their own pace.

The effectiveness of crowdsourcing as an enabler of consumer empowerment is also supported by Adam Smith's "invisible hand" theory [69], which conjectures that even in the absence of communication, collective problem solving (to make more informed purchases) is superior to individual problem solving. Smith's "invisible hand" was defined by Friedman as "the possibility of cooperation without coercion" [18, p. 3]. In the same context of cooperation, Zwass defined "consumer empowerment" to be the ability to "effectively interact with the world on different levels (thus, personal, dyadic, group, and community, but also an opening of the real self to the world) and to accomplish activities heretofore unachievable, and engage in a search for meaning" [83, p. 37].

Füller et al. [19] further identified the factors that influence consumers' perceived empowerment and their willingness to co-create alongside producers as (1) experienced tool support, (2) user involvement, and (3) enjoyment. This is consistent with Bandura [5], who showed that people's self-efficacy is strengthened with (1) enjoyable fun during traditionally stressful activities, (2) encouragement, (3) observing others' success, and (4) achieving mastery of an activity. In encouraging further co-creation by consumers, Zwass also stressed the empowering capabilities of "virtual prototyping tools with immediate feedback, wide solution spaces affording users broad control, and congenial user interfaces that foster realistic understanding of the product under development and creative articulation of the co-creator's ideas" [83, p. 37], which can increase consumer involvement. According to the elaboration likelihood model (ELM), consumers process information differently depending on their level of involvement [55, 56, 57, 73]. Therefore, by increasing consumer involvement, such as by using empowering capabilities of mobile device capabilities [83, p. 37], m-commerce innovations can increase consumers' intention to buy a product or a service.

The Triandis theory of human behavior [32, 75, 77] further supports the importance of consumer empowerment with respect to purchasing intentions. According to this theory, consumers' purchasing intentions can be determined based on their "cognitive and affective evaluation," along with the effect of "social factors" [32, p. 62]. This is also consistent with what Atlee has called "group magic" or "mutual attunement," which can lead to "dissolving of boundaries, barriers, and battles of individualism (ego) in order to better tap the powerful essence of individuality (i.e., uniqueness and individual capacity) in the context of collective activity" [3, p. 11]. The noetic (spiritual) value of communities stems from the coming together of groups of individuals who believe in the same cause or have similar interests.

The recent integration of m-commerce with social networking sites such as Facebook and Twitter highlights the "social factors" dimension of the Triandis

theory. Many have argued that, in order to engage consumers, a shopping experience should address both the cognitive and social sides of the user [16, 36, 37, 53]. Kumar and Benbasat noted that “shoppers have become guests, shopping has become an experience and malls have become entertainment centers with communities” [36, p. 8], and recent studies have drawn on social presence theory [67] to explain how important it is for an Internet medium to allow human contact and sociability [16, 80]. “Social shopping,” that is, mobile commerce with integrated social networking aspects, has been categorized in prior literature as a hedonic activity [2, 15, 23], with authors arguing that the sense of community with friends and total strangers offered by “social shopping” generates a playful experience. It has been noted, in particular, that consumers’ use of m-commerce systems is frequently enhanced with such “playful, interesting, challenging, and meaningful” activities [19, p. 79]. Belk et al. [7] showed that when users reach a state of *jouissance* when performing a task, they tend to repeat the task to experience the same elation. Pihlström [58] also emphasized that the value of mobile services lies not only in their utilitarian elements, but more important, in their hedonic characteristics, and Hong et al. [24] showed that perceived pleasure and enjoyment are critical requirements of consumers’ mobile service usage.

Although many of these characteristics are present in both e-commerce and m-commerce systems, the nature of the interaction between mobile technologies and consumers makes their significance more pronounced in the case of m-commerce. The playfulness, interactivity, and ubiquitous accessibility of mobile devices, along with the sociability, the tactile nature of the interaction, and the portability of the experience, all align with the factors discussed above. Apple’s late visionary Steve Jobs expressed the notion that “software is the user experience” [82, p. 324]. In addition, Cyr et al. [13, 14] found that “the aesthetics of a mobile interface” [13, p. 951] and the “look and feel” of the interface have a significant impact on consumer enjoyment. Sarker and Wells also found that although mobile users are “quite forgiving of physical limitations of the device due to technological constraints, they were bothered by flaws in the interface of the devices” [62, p. 37]. In the context of m-commerce, it is therefore both the software (applications) and the hardware (interface) that ultimately enable the richness of the user experience, and thus it is the combination of these two m-commerce innovation aspects that can help to empower consumer co-creation alongside organizational innovators.

While m-commerce innovations have been instrumental in empowering the end user, they have also resulted in improved productivity, reduced costs, and empowerment for firms [47]. The automated aspects of m-commerce allow firms to cut down on personnel at brick-and-mortar offices and at call centers. More important, firms are learning from consumer blogs, reviews, ratings, and feedback about how to improve their products to better meet consumers’ preferences and thus to support their continuing relationship with those consumers. From the standpoint of continuing to enable customer co-creation of value with the organization, the ongoing development of such relationships can help reveal more innovative ideas and insights, even without explicit intention [8]. This can thus provide additional opportunities for both sponsored and autonomous co-creation.

The value of consumer empowerment and co-creation to the m-commerce industry is said to exceed that which is implied by the marketing discipline's "consumer-centrism" definition of co-creation [9, p. 357], in which co-creation is considered merely to be the democratization of innovation. In fact, Zwick et al. [85] argued that bringing consumers in as partners in co-innovation and co-production within the realm of the information economy (of which m-commerce has become an intrinsic part) is a strategic necessity to address their sophisticated and ever more demanding needs. They also argued that such co-creation rereasonizes growth and innovation on the part of firms, providing them with both economic and strategic incentives to pursue innovation. Consumer empowerment and co-creation have thus spurred the creation of a "post-Fordist" [84, p. 228] form of capitalism, where the production of tangible commodities has been superseded by the production of "knowledge-intensive" intangibles such as patents.

Given this theoretical foundation for the relevance of consumer empowerment and co-creation to m-commerce, we seek to determine the extent to which its presence is actually exhibited in the ongoing development of m-commerce innovations. Prior research has used patent-related indicators to quantify innovation [1, 21], and, in particular, Aghion et al. [1] measured the intensity of innovation using the average number of patents established by firms in a particular industry. We similarly expect patent records (as "visible" indicators of innovation) to show the growing importance of co-creation in rereasonizing innovation in the context of m-commerce.

In order for us to characterize the industry's evolution from its early unrealized potential to its current level of support for consumer empowerment, we must look at a number of years of historical patent information. It is thus important to use an automated technique to extract and analyze the major concepts reflected in the record [76]. A number of such techniques have been used not only to generate an analytic measure of the extent to which different patents are similar in content [48, 76] but also to create a visual representation of the relationships inherent in the patent data [38, 72, 81]. There also can be value in applying a clustering or categorization technique to the data in order to extract significant characteristics about the relationships between the different patents [10, 45, 74].

With this in mind, our research methodology employs a combination of social network and clustering analyses in order to visualize the evolution of m-commerce innovations over time and to determine a set of focal areas that characterize m-commerce innovation. SNA is a well-known data analysis technique that supports both quantitative and visual analysis of the relationships between concepts [35, 38], yet it has not previously been applied to analyze patent titles' focal themes. Because many SNA implementations automatically incorporate clustering algorithms, however, the use of SNA also provides the opportunity to use cluster analysis for further assessing the relative importance of each concept (or focal innovation topic, in our context), based on the strength of the relationships with which it is associated. The combination of these two techniques thus supports our effort to examine whether or not the theoretical importance of topics such as consumer empowerment and co-creation is

reflected in the patent record and thus whether these topics are exhibited as important aspects of m-commerce innovation.

## **Research Design**

### ***Data Collection and Processing***

To capture representative data on the evolution of m-commerce innovations, we collected all patent applications related to m-commerce that were filed with the United States Patent Trademark Office (USPTO) as of January 1, 2011. M-commerce (as well as e-commerce) patents belong to patent class 705 [34]. Using the USPTO query engine, we queried all the patents that belong to patent class 705 and that have the key word "mobile" mentioned anywhere in their abstracts or titles. We found a total of 2,303 patents meeting these criteria. We then used a commercial Web-scraping program, the Web Content Extractor program ([www.newprosoft.com/web-content-extractor.htm](http://www.newprosoft.com/web-content-extractor.htm)), to extract information about each patent (title, abstract, patent filing date, patent posting date, and patent class).

From this set of characteristics we chose to focus our data analysis on the patent titles because they are concise enough to provide a manageable amount of data and yet sufficiently descriptive to provide an excellent indicator of patent content in and of themselves. This is because the USPTO ([www.uspto.gov](http://www.uspto.gov)) requires that each title be "descriptive of the invention claimed," and if a given title does not closely convey what is claimed in the corresponding invention, then the author is required to substitute "a new title that is clearly indicative of the invention to which the claims are directed." As a result of this, although patent titles are often lengthy, "the loss in brevity of title [is] more than offset by the gain in its informative value in indexing, classifying, searching, etc." ([www.uspto.gov/web/offices/pac/mpep/documents/0600\\_606\\_01.htm](http://www.uspto.gov/web/offices/pac/mpep/documents/0600_606_01.htm)). The other patent information, such as the patent filing dates and filing firms, was subsequently used to support the analysis of the text-mining results and to better inform the subsequent discussion.

The titles of the 2,303 patent applications obtained from the USPTO Web site were 9 words long, on average, with a 4.5-word standard deviation. The longest patent title had 57 words, and the shortest was 8 words long. The patents' titles contained a total of 21,307 words for an average of 8.98 words per patent application title. We filtered out the following nondescriptive words: &, a, about, across, after, among, an, and, another, any, are, as, at, back, based, being, between, by, can, due, during, each, for, from, further, given, having, if, in, is, it, its, many, of, on, onto, or, other, otherwise, outside, over, such, that, the, their, therefore, thereof, to, towards, under, upon, using, via, when, where, which, while, who, with, within, without. After removing these nondescriptive words, the total number of words was reduced to 14,905, which corresponds to approximately 6.28 words per patent application title. The word set was further refined by grouping words with the same stem (e.g., "present" and "presentation"), where applicable. This resulted in 1,222 unique stems, rein-



forcing the notion that there are many commonalities among m-commerce patent application titles.

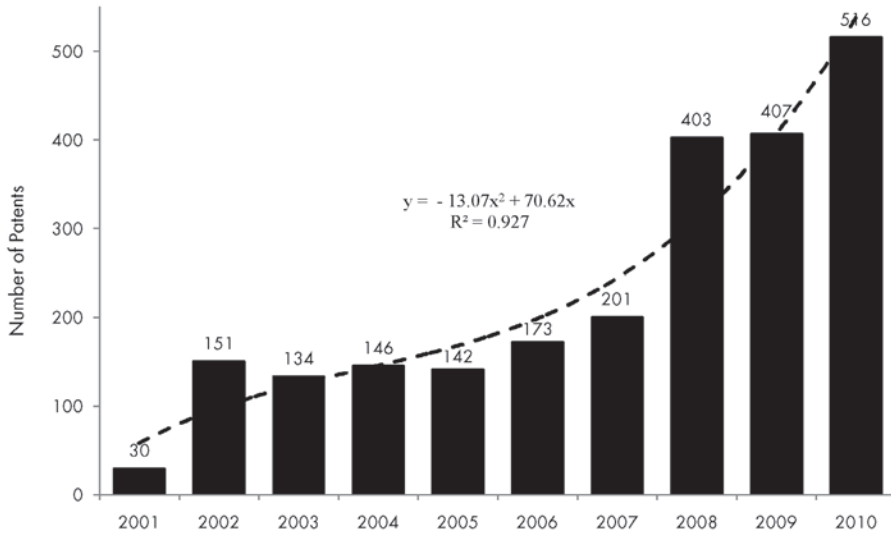
### ***Methodology: Social Network Analysis and Cluster Analysis***

We used SNA to analyze the textual relationships between the m-commerce patent application titles and key words, and thus to uncover trends and patterns in m-commerce innovations. A common starting point with SNA consists of representing a social network as a graph on which entities are nodes and relationships are the arcs connecting these nodes. There are two modes of visualizing entities, one-mode and two-mode (bipartite). In the first mode of representation, nodes representing the same types of entities are related. In our context, this results in establishing relationships between the patent titles or relationships between the key words (such relationships would be defined as “patent titles share the same key word” or “key words appear in the same patent title”). Alternatively, a two-mode representation relates different types of entities. For example, in our context, this would consist of relating patent titles directly to key words (such a relationship would be defined as “patent title contains the key word”). Therefore, for each mode of graph and for different types of entities, the relationships among entities will have different meanings. This aspect of SNA makes it very modular in nature.

To construct a visual representation of any network that includes nodes for the patent titles, the individual titles first have to be coded because embedding the entire title on a graph is quite cumbersome. To do this, we adopted the coding scheme “patent number (year),” where “year” denotes the year that a patent application was filed, and “patent number” the order in which the patent applications were filed with the USPTO in that year (e.g., 1(2010) represents the first social networking patent filed in 2010) [30].

Once the initial relationships between patents and key words were defined, we further conducted cluster analysis to identify focal areas of m-commerce innovation. We used the faction tool of UCINET ([www.analytictech.com/ucinet](http://www.analytictech.com/ucinet)), an SNA program distributed by Analytic Technologies, to identify groups of largely connected nodes in the graphs. While there are many algorithms for forming groups or clusters, including clique formation and block modeling [29, 30], we selected the UCINET’s faction tool because it forms groups by maximizing similarity to an “ideal type” or focal node.

SNAs and SNA visualizations (using UCINET’s Netdraw tool) are typically associated with incidence matrices. For example, the two-mode SNA graph that relates patent application titles to the filtered word set can be represented by 2,303 rows representing patent titles and 1,222 columns representing the filtered word set. Because cluster analysis in UCINET can only be conducted on square matrices, however, a feature in UCINET was used to transform each historical two-mode matrix into two such one-mode square matrices. We opted to dichotomize each such matrix and thus represented the presence of a relationship with a 1 and the absence of one with a 0.



**Figure 1. M-Commerce Patent Applications Filed per Year with the USPTO**

## Results and Discussion

### *Patents Filed per Year*

Figure 1 gives a first glance at the annual distribution of the number of all filed m-commerce patent applications. The dot-com bubble materialized into a meteoric rise of Internet firms from 1995 to 2000 and culminated in March 2000. Figure 1 reveals that m-commerce patent applications began being filed in 2001. This suggests a digestive postbubble stage in which firms started assimilating and embracing the mobile technological advances that were created in the dot-com era and using them to enable m-commerce. While the bubble years were all about e-commerce, our preliminary results reveal a paradigm shift toward m-commerce after 2000. Although it is common belief that m-commerce started only recently, Figure 1 reveals that in reality m-commerce innovations started sprouting a little after the onset of the new millennium.

Figure 1 also indicates that the number of m-commerce patent applications seems to have remained constant at around 140 throughout the quasi-recession following the postbubble stock market crash and the 9/11 terrorist attacks. Starting in 2006, however, the number of m-commerce patent applications grew very quickly, and the filing of such patents seems to be unaffected by the ongoing recession that started in late 2007 as a result of the housing bubble and the credit crisis. Furthermore, because it takes up to two years for a patent application to be posted on the USPTO Web site, the number of patents filed in 2009 and 2010 may actually be much greater than what is portrayed in Figure 1.

### **Patents Filed by Firm**

We were first interested in discovering what firms are filing m-commerce patents. Many patents in our sample were filed by individual inventors or academic institutions and were not attached to any explicit corporation. Among the 2,303 patent applications, only 1,030 belonged to corporations. The total number of firms filing these patents amounted to 442. Table 1 shows the firms that filed more than two m-commerce patents, from most active innovators to least active.

An interesting finding in Table 1 is that a data security company, First Data Corporation, is one of the primary filers of m-commerce patents. This finding alone suggests that information security is an important concern when it comes to m-commerce. The table also indicates that the main innovator in m-commerce overall is IBM, which provides mobile commerce applications such as WebSphere ([www-01.ibm.com/software/websphere/](http://www-01.ibm.com/software/websphere/)). The other revealing finding is that Microsoft is now the second leader in m-commerce patent filings, which is expected given the new Windows iPhone UI (<http://archive.msdn.microsoft.com/iPhoneUI/>).

### **Evolution of M-Commerce Innovations**

In the next phase of our analysis we used the available information about patents to examine the evolution of m-commerce innovations over time. We first created two-mode graphs of the relationships between the m-commerce patent titles and the individual key words for each year between 2001 and 2010. Figure 2 provides two examples of these graphs, for the first year (2001) and the last year (2010) of the analysis, in order to visually summarize the extent to which the relationships evolved over this time period. The quantitative characteristics for all of the graphs, including their network densities and node degree centralities, are then provided in Table 2.

Patent application titles in Figures 2a and 2b are represented by circles, and key word stems are represented by squares. The arcs that link the different types of nodes are directed from the patent titles to the key words and represent the relationship “patent title  $x$  contains word  $y$ .” The average degree of a key word node (i.e., the number of connections to other nodes) is an indication of how prevalent this key word is and therefore how frequently it is included in m-commerce patent applications. With this in mind, Figures 2a and 2b illustrate the degree centrality of each individual node by equating node size with the number of connections. A larger node thus suggests the node is well connected and, arguably, of higher importance.

If a key word has a high degree centrality value, this indicates that it is widely mentioned in m-commerce patent titles and thus represents a focal innovation area during the corresponding year. The key words with the highest degree centrality measures are therefore shown at the outskirts of the yearly networks so as to clearly point out the focal m-commerce innovation areas during these years. Note that in order to account for the lexical variants of

**Table 1. M-Commerce Patents Filed per Firm (If Number of M-Commerce Patents > 2).**

<b>Firm</b>	<b>Patent count</b>	<b>Firm</b>	<b>Patent count</b>
IBM	40	Kabushiki	5
Microsoft	32	Mobile Candy Dish	5
Samsung	26	Siemens	5
Research in Motion	24	Velti	5
Qualcomm	23	Apple	4
NEC Corporation	22	Cisco	4
Nokia	22	Logomotion	4
First Data Corporation	21	Lucent Technologies	4
Yahoo!	21	Pantech	4
Fujitsu	18	Pom	4
AT&T	17	SMS	4
Sony	16	Toshiba	4
Cvon Innovation	14	Vidicom	4
I.D. Systems	12	30 Second Software	3
Motorola	11	Astorenearme	3
NTT Docomo	11	Cingular Wireless	3
American Express	10	G-Xchange	3
Firethorn Holdings	10	Ianywhere Solutions	3
Philips	10	Industrial Technology Research Institute	3
Sybase	10	Integrated Media Measurement	3
Boku	8	LG Electronics	3
eBay	8	Matsushita Electric Industrial	3
Obopay	8	Medaxion	3
Palm	8	Mitsubishi Denki Kabushiki Kaisha	3
Visa	8	Mobilekash	3
General Electric	7	NCR	3
Accenture	6	Paycool International	3
Appsware Wireless	6	SAP	3
Bank of America	6	SK Telecom	3
Electronics & Telecommunications Research	6	Swisscom Mobile	3
JumpTap	6	Boeing	3
Ericsson	6	Western Union	3
Xerox	6	T-Mobile	3
Admob	5	Google	3
General Motors	5		

the same word stem, we have used word stems rather than complete words in Figure 2 and in Table 2.

Overall, Figures 2a and 2b and Table 2 suggest that since 2001 there has been a significant increase in both the number of nodes (distinct key words and patent applications) and the number of relationships between those nodes. More

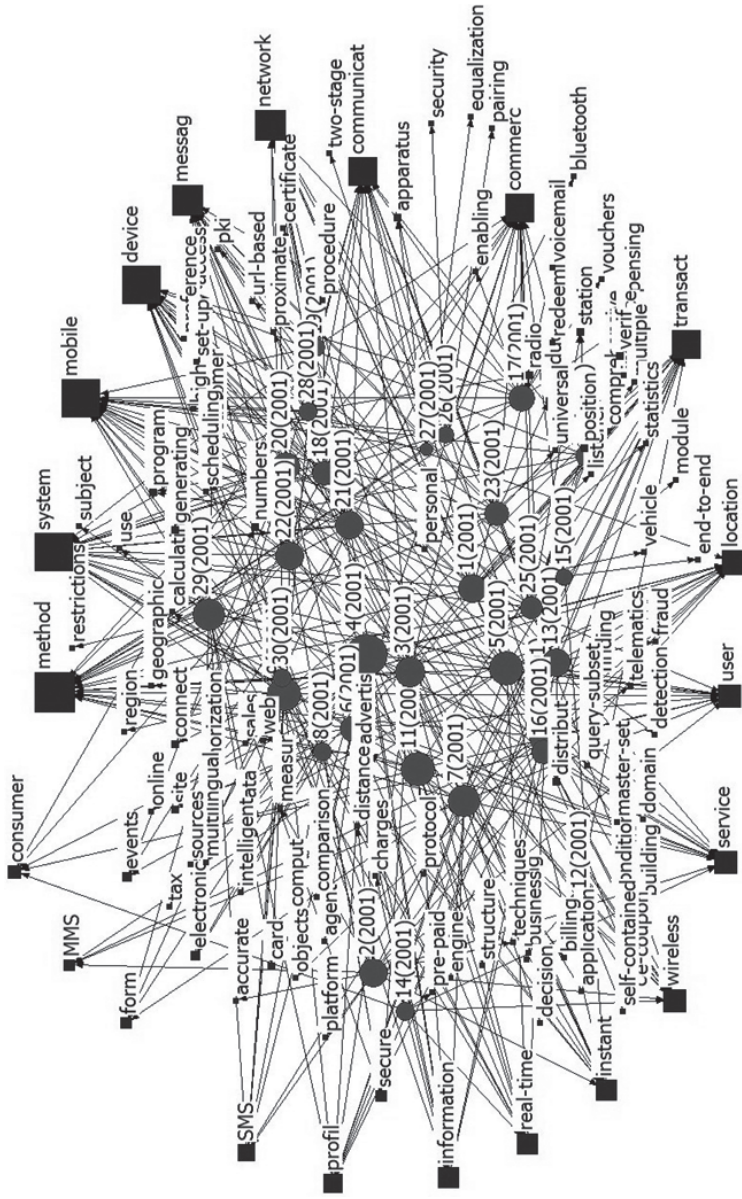


Figure 2a. Mapping M-Commerce Patent Titles to the Selected Word Set in 2001

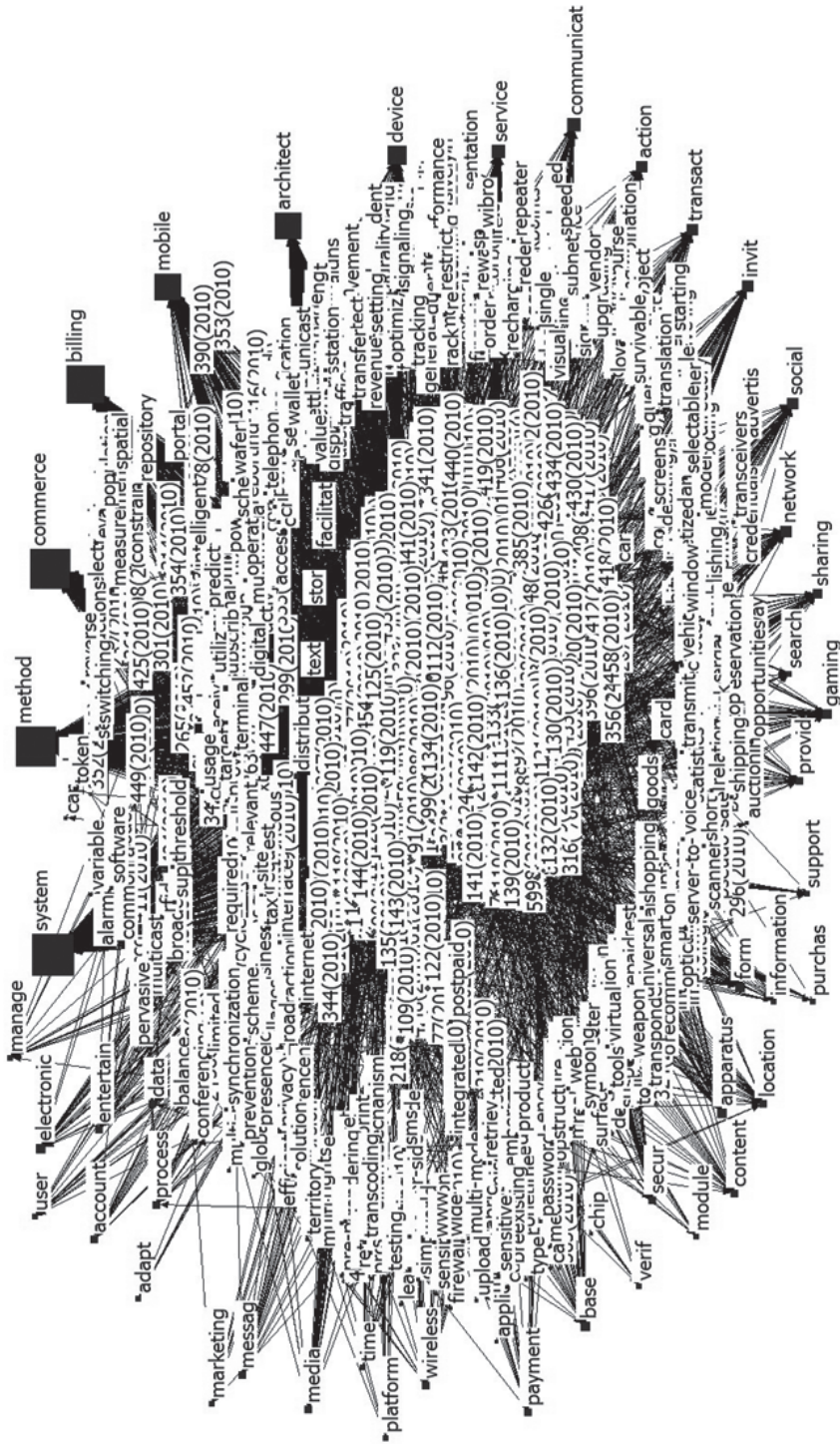


Figure 2b. Mapping M-Commerce Patent Titles to the Selected Word Set in 2010

**Table 2. Network Characteristics for Yearly Graphs (2001–2010).**

<b>Patent applications (number of circle nodes)</b>	<b>Words (number of square nodes)</b>	<b>Number of arcs in network</b>	<b>Average degree of patent application nodes</b>	<b>Average degree of word nodes</b>	<b>Word nodes with 20 highest degree</b>
30	108	215	7.17	1.99	2001 Method (21), system (20), mobile (20), device (20), messag (15), network (15), communicat (14), commerc (14), transact (14), location (12), user (11), service (11), wireless (11), instant (10), real-time (10), information (10), profil (9), SMS (8), advertis (5), consumer (5), MMS (4)
151	300	1,120	7.42	3.73	2002 Method (72), system (69), mobile (45), device (24), secur (20), communicat (21), service (21), commerc (20), transact (20), banking (20), network (19), apparatus (19), wireless (19), authenticat (19), authoriz (18), pay (18), information (18), access (18), account (17), user (17)
134	292	967	7.22	3.31	2003 Method (75), system (75), mobile (60), device (30), advertis (29), communicat (29), messeg (25), market (23), commerc (28), wireless (28), account (22), chat (20), user (17), request (17), coupon (17), offer (15), consum (15), pull (15), alert (10), text-to-win (10)
146	314	1,065	7.29	3.39	2004 Method (90), system (76), device (71), mobile (65), secur (25), electronic (25), communicat (24), protect (19), sign-on (19), authenticat (17), cryptographic (17), network (17), authoriz (16), biometric (16), service (16), priva (16), signing (15), fraud (14), transact (14), access (12), policy (11)

142	327	1,059	7.46	2005	3.24	Method (76), system (60), scan (50), mobile (47), fan (44), sale (44), device (38), fast (36), coupon (34), electronic (32), register (31), reader (28), ticket (28), barcod (26), pay (25), software (24), valid (22), communicat (20), location (17), network (17)
173	360	1,319	7.62	2006	3.66	Method (70), system (62), privilege (55), identit (53), integrity (46), multifactor (45), authenticat (45), RFID (45), right (42), policy (38), manage (38), authoriz (36), password (35), protocol (35), account (33), access (32), priva (31), secur (31), mobil (25), device (25)
201	378	1,470	7.31	2007	3.89	System (128), method (127), device (73), mobile (71), engage (37), service (37), communicat (31), commerc (28), interact (28), profit (28), manag (28), network (27), transact (26), customer (25), revenue (25), distribut (23), interest (23), channel (23), target (23), user (23)
403	551	3,087	7.66	2008	5.60	System (82), method (81), mobile (53), advertis (36), device (31), personal (31), content (30), interface (30), custom (30), demograph (28), user (27), habit (25), deal (22), present (20), geography (15), sign-on (25), priva (20), profile (20), Bayesian (15)
407	551	3,122	7.67	2009	5.67	System (134), method (121), user (74), recommender (6), service (66), device (61), empower (50), network (48), rating (44), media (37), consumer (35), mobile (31), apparatus (28), content (24), engage (24), polic (19), profil (18), verifiable (18), preference (17), manage (16)
516	648	3,955	7.66	2010	6.10	System (252), method (242), commerc (241), billing (225), mobile (151), architect (146), device (103), service (65), communicat (58), action (55), transact (53), invit (51), social (49), network (48), sharing (41), gaming (36), viral (35), connect (20), play (15), compet (12)



circles imply more patent applications and more squares imply more diverse patents, at least as far as semantics and topical areas are concerned. However, the average degree of patent application titles, which serves as an indication of the number of nondescriptive words in patent titles, has ranged, on average, between 7 and 8 words for all the considered years. In terms of word count, considerable jumps seem to have occurred from 2001 to 2002 (increase by 178 percent) and 2007 to 2008 (increase by 45.77 percent). The parallel increase in the number of words and the number of patents indicates that innovation topics are becoming more diverse and that m-commerce innovation topics are expanding or becoming more specialized. The average key word degree also increased considerably from 2001 to 2002 (increase by 87.44 percent) and from 2007 to 2008 (increase by 43.96 percent), indicating that individual key words were being used more often, and thus implying the natural formation of common themes of m-commerce innovations.

Table 3 summarizes the yearly data detailed in Table 2, identifying the most common m-commerce innovation topics for the period from 2001 until 2010. It is interesting to note that the results given in Table 3 reveal a progression of innovations, from one-way targeted advertising using push strategies, to the notion of leveraging the power of the consumers and their social entourage, and finally to the development of recommender systems and more socially based m-commerce capabilities. The following discussion examines this evolution of m-commerce innovations in more detail.

### *2001 (2003, 2010): Mobile Marketing (Push, Pull, Social Networking Based)*

Shankar and Balasubramanian defined mobile marketing as “the two-way or multi-way communication and promotion of an offer between a firm and its customers using a mobile medium, device or technology” [65, p. 118]. In order to realize effective mobile marketing, companies need to know their customers and leverage that knowledge to “deliver highly relevant messages; namely messages that reflect their personal preferences as well as possibly their locations or other contextual attributes” [61, p. 42]. As indicated in Table 3 (for 2001), early mobile marketing efforts were focused on utilizing data pertaining to users’ behaviors, including their location, in order to facilitate targeted advertising that is pushed at the consumer.

Table 3 also indicates, however, that there was a change from push-based marketing to pull-based strategies starting in 2003, when the focal m-commerce innovation efforts became more in line with consumers’ willful participation. This move toward permission-based marketing was driven, in part, by the enactment of privacy laws that forbade sending unsolicited advertising to mobile users [12]. Companies have also realized that well-targeted but unsolicited messages can discourage current and potential customers, thus severely backfiring on a marketing campaign.

More recently (2010 in Table 3), m-commerce has leveraged the power of social networks to unleash their ads and connect to new consumers worldwide. As a result, it is projected that firms’ spending on mobile marketing

**Table 3. Evolution of M-Commerce Innovations (2001–2010).**

	<b>Focal patent terms</b>	<b>Focal m-commerce innovations</b>
2001	Real-time targeted advertising; instant messaging (SMS/MMS)-based advertising; location-based profiling; push mobile marketing	Push mobile marketing
2002	Mobile banking; security; authentication; trusted communication; payment authorization	Secure mobile banking
2003	Pull mobile marketing (chat; alerts; text-to-win; call-back; non-intrusive)	Pull mobile marketing
2004	Fraud detection and reduction; privacy and protection policies; biometrics; cryptographic signing	Privacy protection policies
2005	Mobile ticketing (mobile couponing; mobile barcoding)	Mobile ticketing
2006	Identity and access management; RFID; multi-factor authentication	Identity and access management
2007	Customer engagement; intelligent interactivity; revenue optimization	Customer engagement and empowerment
2008	Intelligent personalization of content; in-app advertising	Intelligent personalization
2009	Recommender systems; consumer empowering; user co-creation; mobile word of mouth	Recommender systems; mobile word of mouth; and consumer co-creation
2010	Mobile data sharing; social networking-based mobile marketing and gaming; mobile commerce network architecture, policies, and billing;groupon	Social networking-based mobile marketing; social networking-based m-commerce and entertainment

worldwide will exceed \$24 billion by 2013 [27]. Consider the case of Nike: After filming its now famous three-minute “Write the Future” commercial featuring several international soccer superstars, the sports clothing company launched the video as an ad on Facebook. eWOM recommendations of this commercial subsequently helped Nike’s Facebook page increase its fan base from 1.6 to 3.1 million users in a single weekend [71]. Nike’s chief marketing officer, Davide Grasso, said that Facebook “is the equivalent for us to what TV was for marketers back in the 1960s. It’s an integral part of what we do now” [71].

*2002 (2004, 2006): Secure Mobile Banking (Privacy Protection Policies, Identity and Access Management)*

Mobile banking applications are defined by Hu et al. as applications that use mobile devices to pay for services, goods, bills, and “transfer funds (bank to mobile, bank to bank, mobile to mobile)” [26, p. 6]. As the demand for such applications became more prevalent over time, legislation controlling the transfer and use of private customer information triggered more security and privacy-based m-commerce innovations (Table 3: 2002, 2004, and 2006).

For instance, the Federal Financial Institutions Examination Council (FFIEC) Guidance of November 2005 recommended that financial institutions and their application service providers deploy security measures to reliably authenticate their online banking customers through use of multifactor authentication, layered security, and other reasonable controls that mitigate risks [33]. This guidance has subsequently triggered a new generation of innovative and cost-effective authentication services and products.

Table 3 indicates that many of the focal m-commerce innovations in 2006 were in the area of identity and access management (IAM), which is particularly relevant in the context of m-commerce. The information security ontology from the National Institute of Standards and Technology (NIST), a division of the U.S. Department of Commerce, and the International Data Corporation taxonomy of IT security ([www.idc.com](http://www.idc.com)) define IAM as technologies that relate to authentication (including biometrics, tokens, and smart cards), authorization, security policies (including privacy management), identity management (including federated identity, credential management, single sign-on, public key infrastructure, enterprise security assessment and provisioning, and directory services), access control and trust management (including privilege escalation and digital rights management, or DRM), vulnerability management (including policy and compliance, radio frequency identification or RFID, and forensics), threat management and prevention (including virtual private network, or VPN, and risk management), and, last but not least, licensing (including authoring, signatures, and certificates).

### *2005: Mobile Ticketing*

Table 3 further indicates that mobile ticketing patent applications started to gain increasing importance in 2005. Although mobile ticketing had existed much earlier (e.g., Helsinki Public Transportation started offering mobile ticketing in 2001 [46]), innovative m-commerce technologies for ticket delivery and distribution and location-based innovations have helped to take mobile ticketing to a much higher level. Consumers now can often present electronic tickets on their mobile phones thanks to barcoding and scanning innovations. In London, for example, award-winning Masabi's Chiltern Railways mobile ticketing application ([www.chilternrailways.co.uk](http://www.chilternrailways.co.uk)) allows railway travelers to buy tickets on their smartphones and to get on train rides just by scanning their ticket's barcode on their mobile devices.

### *2007: Customer Engagement and Empowerment*

The year 2007 marked the beginning of a new era of commoditization of mobile devices and mobile commerce with the release of Apple's iPhone. Although earlier forms of smartphones had existed since 1993, these smartphones were prohibitively expensive and cumbersome [60]. It was not until 2007, when Apple unveiled its iPhone and its operating system iOS, that m-commerce finally took off. The m-commerce revolution continued to get a boost with

Google's Android operating system, unveiled in the fall of 2007 and released in 2008, and with Motorola's Droid, an Android-based smartphone released in 2009. The iPhone was designed with entertainment in mind, and although it was unveiled before the iPad's release in 2010, it was born with a tablet's multitouch feature [28, pp. 467–468]. The touch and feel and resolutions offered by mobile devices add to the realism of the purchasing experience by making it possible to touch a product virtually prior to its purchase. Shoppers can now quickly check prices and read reviews about products, even while shopping in stores, in order to ensure that they get the best value for their dollar. Retailers are especially encouraging consumers to use their mobile devices to shop by offering them better deals and secure, fast, and reliable checkouts.

Consumer empowerment, however, goes beyond offering consumers applications and tools to save money. The Free2Work m-commerce application ([www.free2work.org](http://www.free2work.org)), for example, gives consumers information about the secrets of companies' supply chains and warns them about child forced labor in products. This empowers consumers to make informed decisions and to impose their values and beliefs on firms, possibly shaping the future decisions of these firms.

### *2008: Intelligent Personalization*

The results for 2008 indicate that the concept of intelligent personalization has become very important for m-commerce. The advantages of targeted advertising, mobile banking, e-ticketing, and consumer empowerment are all strengthened by tailoring services to a user's personal profile and by allowing users to incorporate their preferences into their interactions with their mobile device. Considering that users do not like to enter their personal information more than once when performing an online transaction, mobile operators (such as banks and mobile portals) become a repository of personal information and preferences. For example, users can enter their user name and password only once to access their Gmail account on their phones. The user information is then saved on the device for convenience.

### *2009: Recommender Systems, Mobile WOM, and Consumer Co-Creation*

The next phase of innovations reflected in Table 3 (2009) indicates the growing importance of recommender systems as a means of WOM information sharing and co-creation of value for consumers. Product and vendor ratings that are voluntarily provided by users are useful to other customers because they allow for a smarter and less error-prone customer buying experience. Product blogs and review forums are a source of free information about products and brand comparisons and constitute a form of autonomous co-creation of value [83]. Amazon.com's portal, for example, posts ratings for its products based on prior customer experience and statistics of what products customers are more likely to buy after searching for a particular product. In a similar manner, Angie's List

and Yelp synthesize the reviews of qualified customers and create derivative lists that provide aggregated and systematized reviews [83].

### *2010: Social Networking-Based M-Commerce and Entertainment*

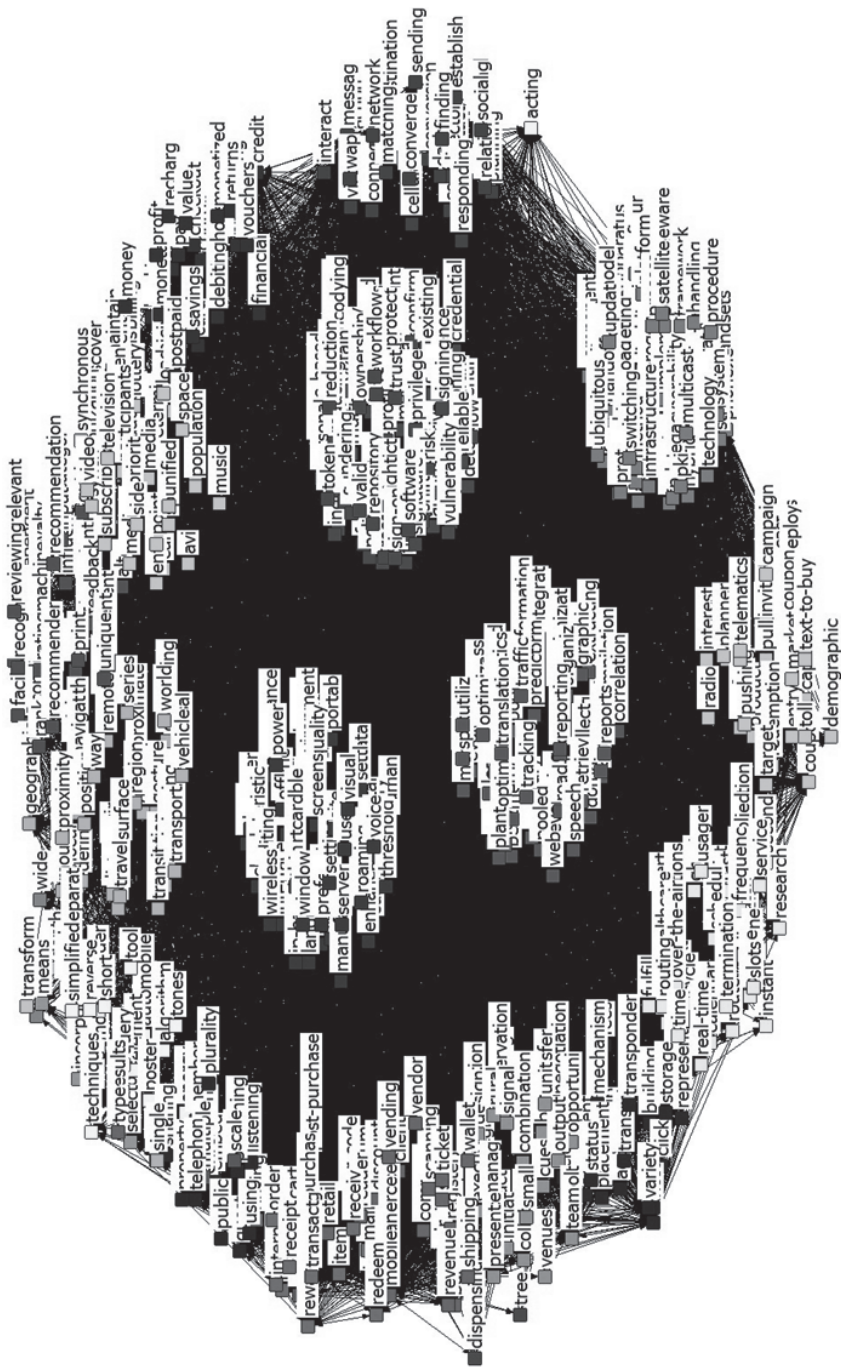
The results for 2010 show that the focal m-commerce innovation themes reflected in the patent applications were social shopping, along with entertainment and mobile gaming. Group buying sites such as Groupon and LivingSocial have become increasingly more popular, and companies can now effortlessly create fan sites or fan communities for their stores, brands, or products using a social networking tool. The mobile gaming industry has traditionally been a big part of m-commerce, and the iPad, released by Apple in April 2010, is widely believed to have been designed with mobile gaming in mind [28].

Penttinen et al. noted that “mobile games are one of the largest mobile application areas and one where users are often willing to pay for services” [54, p. 5]. Many such applications are initially free, but a premium is charged for increasingly higher levels of functionality. In analyzing such applications, a 2010 Juniper Research report (<http://juniperresearch.com>) found that in-app revenues—money spent by mobile gamers after initially downloading an application—have surpassed pay-per-download revenues and are expected to reach \$11 billion globally by 2015. Even in the case of free games, there is often advertising revenue to be gained. Juniper Research estimated a tenfold increase in within-app advertising, from \$87 million in 2010 to \$894 million by 2015.

## **Taxonomic Framework of M-Commerce Innovations**

To provide a comprehensive overview of the overall range of m-commerce innovations from 2001 to 2010, we performed an additional cluster analysis of all 2,303 patents at once. Given that the data revealed 1,222 unique key word stems, we constructed a one-mode graph (or co-occurrence network) based on the square  $1,222 \times 1,222$  incidence matrix relating words to words. The relationship in this network is not directed and can be defined as “word  $x$  appears in at least one patent application title with word  $y$ .” This type of network has been widely utilized to undergo co-authorship and co-citation research [35, 38]. To obtain the co-occurrence network shown in Figure 3, we loaded the group assignments, assigned by UCINET’s faction tool, as attributes in NetDraw to cluster the word-by-word network. The tool was able to classify 690 out of the 1,222 filtered words into 17 major groups of 5 words or more, as shown in Table 4. The remaining words were grouped into clusters of size 4 or smaller and are not represented in Table 4.

The significance of these clusters, as compared to those discussed in the previous section, lies in the fact that they encompass the entire history of m-commerce innovations. As such, they provide a more general overall view of the relative importance of the different innovations that have been identified. Furthermore, they are able to characterize the persistence of innovations that may have developed more slowly over a span of several years.



**Figure 3. Graph of Key Words from M-Commerce Patent Application Titles**

**Table 4. Groups Obtained on Word Sets.**

Group	Key words	Focal area
1	<p>Mobile device design; customization, personalization, and identification</p> <p>Apparatus, architecture, automat, centralized, compatible, complete, complex, component, configure, dedicate, default, desktop, develop, device, digital, disable, display, dock, download, drag, electric, electronic, enable, engineer, error, feature, framework, function, GSM, handheld, handle, handset, hardware, heterogeneous, hybrid, implement, infrastructure, install, interoperable, LAN, layer, legacy, level, method, model, module, motor, multicas, optical, PDA, peripheral, pervasive, phone, photographic, physical, PKI, platform, process, protocol, proxy, resolution, satellite, sensor, switch, system, technology, telecom, update, upgrade, UPS, utilize, wimax, xml</p>	<p>Mobile device design (user-friendly designs; standardization and interoperability; increased usability; affordability and reliability); ubiquitous internet connectivity; anywhere-anytime access</p>
2	<p>Battery, custom, appearance, aware, Bayesian, booking, browser, button, camera, change, characteristic, content, culture, data, deal, demand, dynamic, easy, efficient, enhance, environment, experience, habit, human, idle, instrument, intelligent, interface, language, lingual, memory, menu, offline, picture, portable, portal, power, preference, roam, screen, setting, site, smart, sound, synchronize, usable, user, view, visual, voice, window, wireless</p>	<p>Customization, personalization, and identification</p>
3	<p>Mobile commerce</p> <p>Advise, ATM, banking, billing, broker, card, cash, charge, check, clearinghouse, compensate, contract, credit, currency, debit, deposit, entitlement, escrow, estate, exchange, expense, finance, fixed, flexible, fund, invoice, lading, loan, maximize, money, mortgage, pay, price, procure, profit, recur, return, rich, saving, stock, subsidize, tariff, teller, value, voucher</p>	<p>Mobile banking; faster and more convenient payment options</p>
4	<p>Acknowledge, adopt, amount, balance, bid, buy, cart, internet, item, order, package, purchase, receipt, redeem, reward, shop, success, transact</p>	<p>Mobile shopping</p>
5	<p>Barcode, clearance, client, commerc, commodity, consumer, cost, customer, deliver, demonstrate, discount, enterprise, fan, merchant, mobile, reader, rebate, register, retail, revenue, sale, scan, ship, ticket, trade, vend</p>	<p>Mobile B2C commerce; mobile ticketing</p>
6	<p>Active, agreement, auction, claim, click, close, commission, dual, fee, host, listing, mechanism, pairing, place, premium, represent, resell, shoe, showroom, status, store, transmit, transparent, variety</p>	<p>Mobile C2C commerce</p>
7	<p>Address, call, chat, communicate, connect, converse, dashboard, destination, dialog, email, empower, engage, establish, extend, find, forward, friend, interact, interchange, lookup, mail, match, message, network, pager, publish, question, relation, reply, respond, send, social, virtual</p>	<p>Social networking-based m-commerce</p>

8	<p>Ads, advertise, administer, alliance, audience, augment, bonus, brand, broadcast, budget, benefit, business, campaign, capable, catalog, channel, computer, coupon, demograph, disseminate, distribute, exclusive, income, interest, invite, market, mass, MMS, notify, offer, paper, product, promote, pull, push, radio, recipient, request, SMS, solicit, survey, target, telematics, text-to-win</p> <p>Adapt, aggregate, analyze, anticipate, assess, associate, behavior, calculate, capture, chart, collect, compare, compile, convert, correlate, cumulative, diagnose, estimate, extract, forecast, gather, graph, history, infer, information, inquire, integrate, interpret, key word, knowledge, learning, leverage, logging, measure, merge, metric, mining, optimize, opt-in, organize, pattern, perform, pool, predict, report, retrieve, ROI, sample, statistic, sum, track, traffic, utility, visit, web</p>	<p>Mobile marketing</p> <p>Push, pull, and social networking-based marketing</p> <p>Behavioral learning</p>
10	<p>Agent, assist, airline, alarm, alert, application, appoint, arrive, available, calendar, carrier, context, cycle, daily, delay, diary, emergency, event, expedite, fare, fast, fleet, flight, frequency, future, grocery, health, help, high, hospital, hotel, instant, intermittent, itinerary, lapse, law, lease, legal, live, lodge, medical, minute, MLS, news, online, passenger, period, quick, rapid, real-time, rent, restaurant, route, schedule, service, speed, spontaneous, static, tax, terminal, time, usage, voting</p> <p>Temporality</p>	<p>Real-time applications and services</p>
11	<p>Area, center, direction, distantly, drive, early, gateway, geographic, global, GPS, international, journey, land, link, local, location, map, movable, navigate, position, proximity, region, remote, seating, street, tourist, transit, transport, travel, trip, universal, URL, vehicle, venue, world</p> <p>Localization</p>	<p>Location- and context-specific services</p>
12	<p>Action, algorithm, banner, criterion, make, manipulate, mark, modify, query, result, search, sponsor, task, tool</p>	<p>Mobile search and increased mobility</p>
13	<p>Access, account, anonym, authenticat, authoriz, biometric, block, certificate, code, compliance, compromise, concierge, confide, control, copyright, credential, critical, crypt, defect, detect, deter, directory, enforce, evidence, federated, filter, fraud, genuine, identify, identifi, image, impression, individual, inspect, integrity, intellectual, interrupt, intervene, intrusive, invent, IP, license, lock, meta, monitor, multifactor, multifactor, ownership, password, permission, personal, policy, prevent, priority, priva, privilege, profil, program, protect, reliable, repository, resilient, restrict, RFID, right, risk, robust, role, rule, safe, seal, secur, sensitive, sign-on, signing, software, tamper, theft, threat, token, trust, valid, verifiable, warning, watch</p> <p>Security and privacy</p>	<p>Security and privacy</p>

(continues)



**Table 4. Continued.**

Group	Key words	Focal area
14	Amusement, applet, assign, audio, auto, AVI, bandwidth, board, cache, car, cartage, case, category, compet, entertainment, facility, gaming, hierarchy, load, lottery, media, movie, music, participate, party, play, plug, pocket, prize, score, set, sport, subscribe, synchronous, television, TV, version, video, viral, widget  Entertainment and comfort	Entertaining applications and games; comforting designs
15	Autonomous, discriminate, encourage, facilitate, feedback, fidelity, goal, improve, incentive, independent, influence, input, intent, interview, loyal, rank, rating, recognize, recommend, relevant, reputation, review, sentiment  Co-creation and community	Recommender systems; mobile word of mouth and consumer co-creation  Community
16	Aid, ailing, charity, club, commit, community, date, donate, family, gift, give, guest, listen, member, oblige, peer, people, public, reach, respect, sharing, spread, syndicate	Community
17	Collaborate, combine, delegate, design, execute, group, initiate, job, labor, lead, manage, meeting, negotiate, opportune, output, panel, practice, present, profession, strategy, supplement, support, tag, team, theoretic, title, transfer, work, write  Collaboration	Collaboration and efficiency
Total classified: 690; Not classified in sufficient size group: 532.		
Notes: GSM = Global System for Mobile Communications; LAN = Local Area Network; PKI = Public Key Infrastructure; UPS = Uninterruptible Power Supply; ROI = Return on Investment; MLS = MapPoint Location Server; AVI = Audio Video Interleave; IP = Internet Protocol; wimax = Worldwide Interoperability for Microwave Access; xml = Extensible Markup Language.		

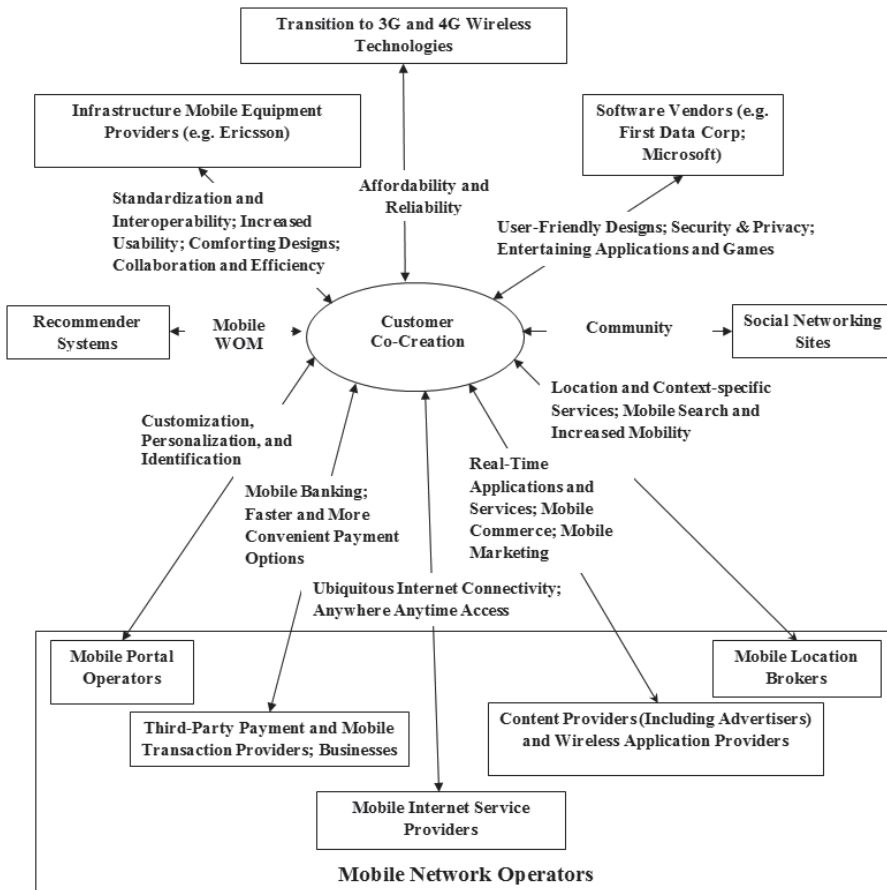
Thus, whereas each of the innovation areas discussed in the previous section (mobile marketing, secure mobile banking, privacy protection policies, mobile ticketing, identity and access management, customer engagement and empowerment, intelligent personalization, recommender systems, mobile WOM, consumer co-creation, and social networking-based m-commerce and entertainment) is included in some context within Table 4, there are also additional focal areas identified. These include broader concepts such as mobile device design, real-time services, and localization capabilities that have been previously identified in the literature as being significant to the success of m-commerce initiatives. There is also an explicit emphasis on the important notions of collaboration and co-creation of value with and between consumers, which, as we have discussed, provide an overarching theme that exists at each of the other levels. The concept of co-creation, in particular, is a fundamental part of current innovation efforts as they have evolved, and it helps to drive and improve the effectiveness of efforts in each of the other innovation areas.

Based on the clusters given in Table 4, and their associated focal innovation areas, Figure 4 provides a taxonomy of the value of m-commerce innovations. Each arrow in Figure 4 represents one or more of the focal innovation areas identified in Figure 3 and Table 4. Radical innovations (such as 3G and 4G wireless technologies), shown at the top of the taxonomy in Figure 4, triggered the m-commerce revolution. According to Snyder, 4G allows “typical users to get over 100 megabits per second (Mbps) to their wireless device anywhere they go” [70, p. 11] and is thus considered a huge step forward in mobile innovation, opening new doors and creating endless possibilities for m-commerce. Without these radical technologies, m-commerce would not have had a chance to evolve. However, our taxonomy portrays the consumer in the center of the m-commerce revolution to express how consumers are co-creating at all m-commerce levels, and the arrows in Figure 4 are bidirectional to emulate the co-creation between traditional m-commerce innovators and consumers. The taxonomy thus illustrates how m-commerce innovations are empowering consumers.

It is important to note that the taxonomy in Figure 4 not only uncovers the focal innovation areas of m-commerce contributors but also differentiates between the various m-commerce value network players and their primary focus on innovation. Many m-commerce innovators are playing multiple roles in this value network. For instance, Nokia, traditionally a mobile device manufacturer, is also competing in the mobile portal market [61]. Similarly, Yahoo!, traditionally a player in the Internet portal market, has leveraged its customer base to offer integrated portal solutions [61].

## **Conclusions, Contributions, Limitations, and Future Research Directions**

While prior literature has studied the importance of mobile applications and mobile devices’ interfaces to the consumer, no prior research has investigated innovations in m-commerce as represented by patent applications



**Figure 4. Taxonomy of How M-Commerce Innovations Empower Consumers to Co-Create**

in this specific area. In an effort to highlight how m-commerce innovations are empowering consumers and enabling their role as co-creators of value in m-commerce, this paper looked at such patent applications from a couple of different viewpoints. First, we characterized the number of m-commerce patent applications from 2001 to 2010 and identified the number of patents filed by different firms to assess the extent of their investment in m-commerce innovation. We then used the patent data to examine the evolution of m-commerce innovations over time and ultimately constructed a taxonomy that showcases the prevalent areas of innovation in m-commerce.

The data analyzed were based on 2,303 m-commerce patent applications from the USPTO Web site. SNA was used to relate the patent application titles to a set of unique focal key words as well as to relate the key words to one another. Cluster analysis was then used to highlight the most prominent key words, in turn revealing the importance of the corresponding m-commerce innovation areas. Our results revealed that m-commerce has matured from a

one-sided marketing tool used by companies to push advertising about their products and services toward their customers to an entertaining social experience in which the users are engaged at all levels and are empowered to create value both for themselves and for others.

Zwass developed a theoretically derived taxonomy for e-commerce as a whole and identified “changing consumer roles and self-perceptions” [83, p. 37] as one of the principal research directions instrumental in furthering the theory of co-creation. Zwass [83] cited Bauman to point out that when it comes to e-commerce, “contemporary society engages its members primarily as consumers; only secondarily, and in part, does it engage them as producers” [6, p. 33]. E-commerce firms are typically in control, even with their intentions to co-create alongside consumers. Despite organizations’ attempts to foster co-creation by engaging customers, their attitude tends to be “reductionist” [83], in part because of the customer’s self-perception as a consumer rather than an innovator.

In contrast to the situation in the more general area of e-commerce, m-commerce has revolutionized the self-perception of consumers by empowering them to voice their beliefs and preferences continuously and instantaneously. As indicated by our analysis, the notion of co-creation is fundamental to the field of m-commerce. As such, there is future opportunity to explicitly consider co-creation in the context of other frameworks, such as the 7C’s and 2M’s mobile interface taxonomy of Lee and Benbasat [39].

M-commerce growth is attributed to the power of consumers to seamlessly impose (and often voice) their preferences and individualities through their small “third screens” (which have become the primary screen for most mobile phone owners) and to co-innovate side by side with innovators in the m-commerce value network. Our proposed taxonomy of m-commerce innovation areas contributes to the m-commerce literature and builds on the co-creation and empowerment theories. Given that m-commerce innovation studies are still at the nascent stage, this paper constitutes a first attempt at clearly differentiating between e-commerce and m-commerce in this context. In doing so, it seeks to highlight the relevance of customer empowerment and co-creation to the m-commerce environment.

This paper provides a contribution to the application area of information mining [20] in that it illustrates the use of widely available public patent data for understanding technological trends and ongoing innovation directions. It also makes a methodological contribution to the literature in that it shows how SNA and cluster analysis can be used to identify innovation trends and patterns. From a practical standpoint, the derived taxonomy emphasizes the importance of co-creation to the various innovators in the mobile value network. It further stresses the importance of redefining the role of mobile users from consumers to co-creators, and it can be used to discover uncharted areas for innovation that could potentially become value-generating for m-commerce innovators.

The timeline showing the evolution of m-commerce innovations is also a major practical contribution of the paper as it provides the first attempt to empirically map this process. The focus on security, consumer privacy and fraud detection, and identity and access management in 2002, 2004, and 2006,

respectively, is especially revealing in that, while revolutionary, m-commerce is still fraught with security risks. The recent integration of m-commerce with social networks also provides tremendous practical insights into the future potential for applications and services in the realm of social commerce. More generally, both the timeline and taxonomy bear practical insights to m-commerce innovators on what they need to focus on in their products and services to be successful in the m-commerce market.

Some limitations stemming from the data collection and the methodological approach used in this study are inevitable. First, although the *factions* clustering algorithm in UCINET has been widely used in the literature [49], it is a heuristic and therefore not as robust as a more mathematically based algorithm would be. Furthermore, the patent data collected from the USPTO Web site for 2010 (and possibly also for 2009) are not complete since it takes, on average, a year for such patent applications to be posted. There are thus more recent submissions that were not included in the analysis.

The choice to use patent applications, rather than actual accepted patents, was based on the fact that it typically takes four to six years for a patent to be accepted. Not only would this introduce a greater lag into the timing of the analysis, but it would also significantly reduce the amount of data available to analyze. In any case, the use of patent applications is not considered a significant issue because in the literature they are considered strong indicators of innovation activity [21].

In conclusion, it is apparent that mobile devices have changed e-commerce as we know it by empowering consumers to make better decisions and by supporting them, through the use of innovative technologies and services, in the process of creating value for themselves and for others. Not only has this helped to create more efficient and enjoyable shopping experiences for consumers, but it has also allowed retailers to improve their productivity, reduce their costs, and do a better job of providing customers with products that meet their needs and expectations. The taxonomy that we have proposed represents only those m-commerce innovations about which information was made publicly available as of 2010. As the technical infrastructure and the business environment continue to evolve, it is certain that the realm of m-commerce will continue to generate new innovations that will ultimately make a significant impact on our society.

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