Internationalization of indoor positioning platform firms: Insights from loose coupling theory

Arto Ojala
University of Vaasa
arto.ojala@uwasa.fi

Sara Fraccastoro
University of Eastern Finland
sara.fraccastoro@uef.fi

Mika Gabrielsson
Hanken School of Economics
mika.gabrielsson@hanken.fi

Abstract

Indoor positioning platforms are gaining popularity in various indoor environments, serving multiple purposes such as navigation, asset tracking, proximity marketing, and indoor analytics. However, the diversity of potential use cases and technical complexity makes these platforms challenging to internationalize across different markets and customer segments. Drawing on the characteristics of digitalization framework and the loose coupling theory, we analyze and explain the phenomenon in an indoor positioning platform firm. Our findings reveal that platforms' openness and digital affordances played a pivotal role in its internationalization by enabling customization of the service to meet the needs of foreign markets and industry segments. Both loose and tight couplings were essential for the platform's global expansion. We also revealed the dynamic nature of couplings in the firm's internationalization journey.

Keywords: Digital platforms, Indoor positioning, Characteristics of digitalization, Loose coupling theory, Case study.

1. Introduction

Global positioning system (GPS) satellites have long been used for outdoor positioning of devices (Geotab, 2020). However, indoor positioning is a more challenging task as GPS cannot be utilized, nor can a single technology be relied upon (Dedes and Dempster, 2005). Despite these obstacles, the demand for indoor positioning solutions, such as indoor navigation, has increased significantly in the last decade. Solutions like indoor navigation provide a wide range of services to different business sectors and industries, including shopping malls, trade fairs, airports, storage facilities, metro, and railway stations. According to Gartner's report (2021), the indoor location services market is predicted to generate 55 billion dollars in revenue by 2030, providing a tremendous market potential for firms involved in the development of technologies and digital platforms for indoor positioning.

The development of indoor positioning services is a multifaceted process that involves the integration of multiple technologies (Brena et al., 2017; Wirola et al., 2010). To deliver these services, firms that develop indoor positioning technologies usually offer their products as digital platforms. These platforms allow partners (including third-party integrators, application developers, resellers, and customers), to create services that meet the needs of the end users. Recent research indicates that the market activities of digital service providers depend heavily on the characteristics of digitalization (Kallinikos et al., 2010, 2013; Nambisan and Luo, 2021; Yoo et al., 2010, 2012). Moreover, the success of international expansion for these firms relies on their ability to effectively leverage these characteristics (Ojala et al., 2018; Fraccastoro et al., 2023; Gabrielsson et al., 2021) while aligning with their entrepreneurial capabilities (Ojala et al., 2023).

The end market for indoor positioning platforms exhibits a high degree of fragmentation due to their applicability across multiple industries, customer groups, and end-users, each with distinct preferences and requirements (Brena et al., 2017; Wirola et al., 2010). To cater to these diverse markets, platform providers often open-up their technology to partners who can further develop and commercialize the platform (Boudreau, 2010; Shapiro and Varian, 1998). However, allowing too much openness and having only minimum control over the platform may lead to issues such as misusage and an overabundance of competitive services (Karhu et al., 2018) that may hinder the future platform development and thus have negative effects on its internationalization. Therefore, it becomes crucial for platform providers to maintain a delicate balance of control over the platform. This balance can be studied by applying loose coupling theory (Glassman, 1973;

URI: https://hdl.handle.net/10125/107031
978-0-9981331-7-1

Orton and Weick, 1990; Weick, 1976) to investigate how much openness and/or closeness firms should provide for outsiders to participate in platform development (Hein et al., 2018) and commercialization for foreign markets (Nambisan and Luo, 2021). However, it remains unclear how firms make decisions between loose and tight control and why they provide more openness to some actors while keeping closed couplings with others. Furthermore, we still lack knowledge on whether platform openness/closeness-related decisions have an impact on the international behavior of platform service providers.

Thus, this work aims to address the following research questions: (1) How do indoor positioning firms leverage the characteristics of digitalization for international expansion? (2) How do indoor positioning firms make decisions on loose and/or tight couplings? By addressing these questions, this study aims to provide insights into the strategies employed by indoor positioning platform providers to expand their business globally. We draw theoretical and empirical implications that merge coupling theory in international endeavors and literature on digital artifacts characteristics.

2. Literature review

2.1. Indoor positioning

GPS was originally developed for military use in the US in the 1970s but was later adapted for commercial use in the late 1980s (Geotab, 2020). Today, GPS is widely used for outdoor positioning. However, indoor positioning is more challenging due to the significant weakening of signals caused by walls, roofs, and other physical barriers (Dedes and Dempster, 2005). Therefore, firms developing indoor positioning services use a variety of devices, signals, and algorithms to enable indoor positioning. These technologies include Wi-Fi routers, Bluetooth Low Energy (BLE) beacons, geomagnetic fields, Low Earth Orbit (LEO) satellites, infrared, visible light communication, and others (Brena et al., 2017; Prol et al., 2022). In order to improve positioning accuracy and provide prompt services to customers, firms often need to integrate multiple technologies, making indoor positioning much more complex than standard GPS positioning technology that is easily available via satellites (Brena et al., 2017). These characteristics make indoor positioning services highly malleable (Kallinikos, 2013) and thus applicable to various business segments and markets. These positive elements are however counterbalanced by the fragmentation of the end market for this type of firm that is mirrored in their international behavior which appears to be understudied by academic investigation.

2.2. Characteristics of digitalization

Indoor positioning firms often package their offerings into digital platforms, which allow them to leverage various characteristics of digitalization, such as digital openness, digital affordances, and digital generativity (Nambisan and Luo, 2021). These factors can collectively influence the rate and scope of the platform's internationalization.

First, *digital openness* refers to the extent to which the platform is open to other actors, with the platform provider having the discretion to determine who can participate in its development, the extent of their contribution, and the outcomes that they can achieve (Nambisan and Luo, 2021; Nambisan et al., 2019). An open platform allows other market actors to build and develop it for their own or their customers' needs. For instance, by providing third parties access to the platform, it is possible to tailor it to specific customer or end-user groups in different foreign markets. Nevertheless, excessive openness may also result in negative consequences for the platform developer, such as conflicts, lower-quality offerings, or competing services (Karhu et al., 2018).

Second, *digital affordances* refer to the ways in which digital platforms interact with users' goals and generate new value and opportunities (Nambisan and Luo, 2021). Because digital platforms allow for actions that are contingent on user choices and goals, developers can advance the platform for different purposes and for different foreign markets. This is made possible through boundary resource tools such as software development kits (SDKs) and application programming interfaces (APIs), which the platform provider may offer to external developers (Ghazawneh & Henfridsson, 2013; Karhu et al., 2018). However, the use of these tools may have positive or negative impacts on the platform provider. On one hand, other firms can use boundary tools to further develop the platform for their own goals and make it more suitable for different foreign markets and user groups. On the other hand, they may also develop services that contradict the platform provider's goals (Nambisan and Luo, 2021).

Third, *digital generativity* refers to the capacity of digital platforms to evolve and generate new outputs, structures, or behaviors that were not originally planned by the platform provider (Yoo 2012; Zittrain, 2006). This is made possible by the layered modular architecture of digital components, which can be integrated, recombined, and customized in various ways (Yoo et al., 2010). Changes made to one layer can trigger changes in other layers, resulting in new uses or outcomes of the platform (Ojala and Lyytinen, 2022). This reorganization of different components can lead to new innovations or innovative uses of the platform in

global markets, creating value for the platform provider and its partners. However, this generativity can also result in innovations that have negative impacts for the platform provider (Nambisan and Luo, 2021).

2.3. Loose and tight couplings

Indoor positioning firms can leverage the characteristics of digitalization to balance their open and closed platform strategies when launching their digital platforms in global markets. The loose coupling theory, widely employed in organizational studies (Orton and Weick, 1990), can be utilized to further examine this balance. The concept of loose couplings refers to a system that is weakly or infrequently tied together with minimal interdependence (Glassman, 1973; Orton and Weick, 1990; Weick, 1976). In his work, Glassman (1973, p. 83) argues that "the degree of coupling, or interaction, between two systems depends on the activity of the variables which they share". Modular product architecture has facilitated loose couplings at both product and organizational levels (Sanchez and Mahoney, 1996). In this study, we specifically examine loose and tight couplings at the organizational level, as we believe they have effects on strategic decisions about platform organization and subsequent international expansion. Organizational level activities are enabled to a great extent by the characteristics of digital platforms, such as the modular architecture of digital components that are loosely associated (Ojala and Lyytinen, 2022; Yoo et al., 2010). For the purposes of this study, loose couplings refer to actors who use the platform independently and have infrequent interactions with the platform provider, if any at all. On the other hand, tight couplings refer to actors that interact frequently with the platform provider and/or develop the platform together with the provider.

Loose couplings offer various advantages and disadvantages for digital platform providers operating in global markets. Among the potential advantages, as Weick (1976) suggests, loosely coupled systems are beneficial for localized adaptation, as one element can be modified to suit the local context without impacting the entire system. This feature provides greater independence for the platform provider's partners, allowing them to innovate and develop new services that cater to the unique requirements of local users in different foreign markets (Nambisan and Luo, 2021). Additionally, loosely coupled systems offer better sensing mechanisms, meaning that independent actors (partners) have a more comprehensive understanding of their local market environment than in more tightly coupled systems (Weick, 1976). Furthermore, loosely coupled systems may generate a greater number of variations and novel solutions compared to tightly coupled systems, promoting innovation and enabling the platform to be adapted for new purposes and accelerated internationalization. Loosely coupled systems can be also more cost-effective to operate due to the reduced need for coordination between different actors, resulting in lower expenses and faster implementation (Weick, 1976).

Despite their advantages, there are also some drawbacks to loose couplings. In this case, firms have less control over their network of partners, how they use the platform, and for what purposes in global markets, which could result in competing services, legal risks, reputational damage, and other types of risks (Nambisan and Luo, 2021). Tight couplings, on the other hand, have their own benefits. For example, they provide a better understanding of customers' needs, tailoring opportunities, improved customer satisfaction, closer relationships, and enhanced trust (Danneels, 2003). In this research, we are interested in looking at both loose and tight couplings.

3. Research method

In order to gain a comprehensive understanding of the internationalization process of a provider of indoor positioning platforms, we adopted single-case study as a methodology, as outlined by Eisenhardt (1989) and Yin (2009). This approach allowed us to delve deeply into the various ways in which the technology and associated digital platform services (as features of digitalization) affected the internationalization of the service provider. Furthermore, this methodological approach was particularly advantageous in exploring hitherto unexamined phenomena, given that there was a paucity of well-established concepts or hypotheses that could be employed to elucidate the phenomenon at hand (Swanborn, 2010).

The case firm, to which we refer as *Innav* for confidentiality reasons, specializes in developing indoor technologies and digital platforms that enable indoor positioning and navigation. Innav was founded in 2012 and by 2023, it had over 10,000 developers registered across 130 countries, utilizing its platform services to develop applications and complementing platforms. With the majority of their revenue generated outside Europe, their domestic market, Finland, immediately proved to be too small, resulting in only a handful of pilot customers within the country. Innav's internationalization efforts have been rapid since their inception, securing their first customer from China in 2014, followed by Japan (2016), USA (2017), and Thailand (2017). In addition to their headquarters in Finland, Innav maintains personnel in the USA (2013), China (2014), and Japan (2016) to provide technical support with installation and maintenance of the service.

The present study draws upon face-to-face interviews with the founder/Chief Technology Officer (CTO) and the Chief Executive Officer (CEO) of the case firm over a period of five years (2017 to 2022), as documented in Table 1. Due to the small size of the firm (employing 20 individuals), we placed particular emphasis on interviewing the CEO, who held primary responsibility for overseeing business operations and internationalization efforts. In addition to these primary sources of data, we also gathered several types of secondary materials, such as press releases, brochures, and presentations. To gain a more comprehensive understanding of the firm's technology and market activities, we also monitored the firm's website and social media postings. These secondary materials served to validate the data collected from the interviews. In instances where conflicting information emerged between the interview data and the secondary data, we consulted the CEO to clarify any potential misunderstandings.

Table 1. Data collection.

Person interviewed	Time of the interviews	Duration of the interviews
Founder/CTO	January 2018	65 min
CEO	October 2017	55 min
	November 2018	45 min
	September 2022	85 min
	April 2023	65 min

In line with the goal of conceptually validating and extending loose coupling theory in a new context, a deductive approach was employed to analyze the collected data (Hsieh and Shannon, 2005). Our methodology involved a two-stage process. Firstly, we conducted data reduction as per the approach outlined by Miles et al. (2014), synthesizing the transcripts from the interviews and the secondary data into a baseline narrative that presented a chronological history of the key events that had influenced the firm and the platform (Pettigrew, 1990). Secondly, we proceeded to code the interview data based on the predefined themes from prior literature, namely Openness, Digital Affordances, Digital Generativity, Loose Coupling, and Tight Coupling. Nevertheless, we remained open to the possibility of new themes emerging from the collected data (Hsieh and Shannon, 2005).

4. Findings

4.1. Background of the case firm

The case firm, Innav, was founded based on the idea that earth's magnetic fields can be utilized for indoor positioning. While the original concept was conceived several years prior to the establishment of the firm, it was not until the advent of new smartphones by Apple and Android, which included features to measure accelerations, angular velocity, and other parameters, that the service could be brought to market. Innav leverages GPS to approximate the location of a mobile phone, and employs a combination of various technologies, including Wi-Fi, Bluetooth Low Energy (BLE), geomagnetic fields, sensors within the mobile phone, and algorithms, to determine the location of a user or object within a building.

According to the founder/CTO of Innav, when the company was established, there was no actual demand for indoor positioning services in the market. The technology was developed without a clear understanding of its potential applications. However, upon the launch of the new platform for indoor positioning and navigation, the company quickly garnered a significant amount of interest from major players in the industry, such as Google, Apple, Baidu, Yahoo, and others. It was at this point that Innav recognized the market potential of their innovation and how it could be integrated into other firms' platforms.

Innav's indoor positioning and navigation technology has the potential to support a variety of different digital platform-based services, such as indoor navigation services for large buildings (such as metro/railway stations, airports, hospitals, storage facilities, trade fairs, shopping malls, etc.), services to locate people and/or objects inside a building (such as delivering products to customers within a building or finding the nearest security guard, doctor, or needed object), and estimating queuing times (such as in amusement parks or festivals).

In order to address the challenge of varying demands for their services across different environments and technology platforms, Innav recognized the need to develop a standardized platform. This allowed for other firms to further develop and customize the service to meet their specific needs. This approach allowed Innav to serve a wide range of different end-user groups without the need for specialization. As the CEO explained, *"We realized that we cannot cater to all potential segments, as they have vastly different demands for the platform service... and we are not even aware of all the possible use cases. Therefore, we developed the basic technology and offered it as a digital platform. Customers can download it from our website and further develop, customize, localize, or integrate it to their liking. They can use it for their own purposes or sell it to others."*

4.2. Openness and internationalization

Innav's open platform has allowed partners from around the world to utilize and adapt the platform for their own unique needs. The platform's trial version and accompanying documentation can be found on Innav's website, and are available for anyone to use. To use the trial version for commercial purposes, partners must sign a contract with Innav. The platform's openness has facilitated rapid international expansion worldwide as the CEO commented, *"We have around ten thousand registered developers across the globe who are using the platform for their own purposes and targeting different markets."* Further, Innav does not need to worry about customizing or localizing the platform for different markets or countries. According to the CEO, *"We have received a lot of positive feedback about the openness of our platform. Although there are specific algorithms that are kept as trade secrets, such as those used for generating location maps and those that go to the mobile phone, the platform is still considered to be quite open. We have provided good documentation and interfaces for these specific algorithms, which enables partners to easily integrate them into their own platforms."* The only issue arises when partners or customers do not allow the platform to communicate with Innav's cloud service, which prevents Innav from receiving usage data and inhibits partners' ability to make updates to the maps they use.

4.3. Digital affordances and internationalization

Innav offers different tools for their partners that enable the platform development for various purposes and for diverse customer groups in markets spread globally. They have a wide variety of partners developing the platform services for instance to large exhibition halls, metro/railway stations, airports, hospitals, storages, trade fairs, shopping malls, etc. Innav offers wide range of tools that helps their partners to achieve their goals. These tools are for instance Android and iOS compatible SDKs, APIs, digital mapping tools, Unity programming compatibility and more than ten cross-platform development tools. Versatility of these tools enables Innav's partners to add and develop tailored solutions for various industries globally, with the result of making Innav a polyhedric software solution. The CEO commented this: *"We aim to develop this as generic as possible. Our technology is used in airports, hospitals, exhibition halls, but also places like Bangkok's Chatuchak market."* Even Innav's platform technology has been used widely and it has been developed to serve various industries and targets, there has not been anything that contradicts Innav's own goals. Contradicting goals are mainly avoided by using a strategy where Innav develops only platform technology and their partners develop the actual platform service on it for their final customers/end users.

4.4. Digital generativity and internationalization

Innav initially had to innovate various use cases for how their platform could be applied across different industries and markets. However, as time passed, their partners have played a significant role in discovering new ways to use the platform. Innav's strategy was to create a generic platform that could enable as many use cases as possible, recognizing that it would be impossible to anticipate all possibilities. As the CTO/founder explained, *"We aimed to develop a platform that could support a wide range of use cases because we were unable to identify the most promising ones. Instead, we allowed our customers to determine how they want to use the platform."* As a result, this approach yielded to numerous innovative applications of the platform across diverse markets. For example, Innav's CEO cited a case where a partner utilized their services to monitor a radio infrastructure: *"If the Bluetooth beacon or Wi-Fi access point was lost, the platform could inform the customer of its location. This is an excellent demonstration of the platform's generative capabilities."*

4.5. Tight couplings

Innav's main approach to working with key partners was through close partnerships. According to the company, tight couplings were essential in learning about partners' needs, their business mindset, and how Innav could develop its platform to better match those needs. The CEO further elaborated on this approach, stating, *"We have established direct relationships with our key partners, which allows us to communicate with them and understand their goals. This feedback informs our product development, enabling us to create technologies that facilitate new possibilities for our partners."* Innav also recognized the importance of maintaining tight couplings with big or well-known partners in the industry. The firm invested significant resources in supporting these partners as they often had large projects that could generate multiple global business opportunities.

4.6. Loose couplings

Innav has loose couplings with actors who primarily discovered the platform through independent means on the firm's website. These partnerships were considered as being essential given Innav's highly versatile service and the difficulty of identifying the right segments for it. Partners can adapt the platform to suit different segments and foreign markets, leading to successful development and expansion. The CEO stated, *"Our partners are able to use the service without the need to consult us. We have provided comprehensive documentation on how to install and use it, which has received a lot of positive feedback."* The CTO/founder explained this issue as follows: *"We adopted platform thinking from the outset because we recognized that we cannot predict all the use cases where our service can be applied, nor can we identify the most successful one."*

Innav's goal is to expand the number of partners who can independently utilize the platform as a self-service and customize it for their specific needs. This approach enables Innav to enter new market segments and expand their international reach. However, since some technical knowledge is required for implementation, the platform is not yet a fully "off-the-shelf" service. Still, nearly all partner activities, including support, can be completed remotely.

4.7. Loose and tight couplings

There were instances where the relationship between Innav and its partners did not fit into a binary classification of tight or loose coupling, as the degree of coupling varied over time. Some partners initially adopted the platform as a self-service but later sought closer collaboration with Innav, particularly if the platform became integral to their service. Conversely, some partners started with a tight relationship with Innav, but as they gained proficiency in installing, using, and developing the platform, the relationship became looser. However, in some cases, these loose couplings were reestablished as tight couplings when partners entered new markets or segments and needed assistance from Innav. The CEO elaborated on this by giving an example: *"For instance, a partner has developed a navigation solution with us for an office space. They can easily replicate the same installation process for similar spaces globally without our help. However, if they want to implement the same solution in a much larger area such as an exhibition hall, the installation process would require significant differences. While the platform still functions in both cases, seeking our guidance would be beneficial for the partner to ensure a successful implementation [and expansion to new foreign markets]".*

5. Synthesis of the findings and discussion

The characteristics of digitalization (Nambisan and Luo, 2021) have had a significant impact on the internationalization of the case firm. We now draw a synthesis of our findings by illustrating them in Figure 1, that depicts a model in which the strategic options of platform service providers as for internationalization are explained as a consequence of the interplay between digitalization characteristics and loose vs tight coupling. Thus, we suggest three propositions related to the model we advance.

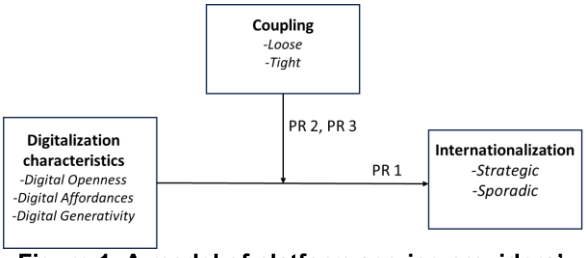

Figure 1. A model of platform service providers' strategic options to foster internationalization in digital context.

Our findings suggest that platform openness played a crucial role in facilitating the speed and scope of international expansion. By adopting a highly open platform strategy, with the firm controlling only the most critical parts of the platform, they were able to rapidly expand to multiple markets globally. Additionally, offering a trial version of the platform through the company's website enabled partners worldwide to test and experiment with the platform on a self-service basis, further enhancing platform openness. This study builds upon the research of Ojala et al. (2023) by demonstrating the significance of platform openness in facilitating rapid internationalization. In addition, our findings indicate that by promoting openness, firms can focus on platform development, while partners play a key role in expanding the platform for foreign markets. As indoor positioning solutions are generic and have a broad range of use cases (Brena et al., 2017; Dedes and Dempster, 2005), the results clearly indicate that platform openness facilitates the coverage of diverse user groups, which are difficult to predict in advance.

Based on the research, it was found that besides openness, digital affordance (Nambisan and Luo, 2021) can also greatly facilitate international expansion. The case firm in question provided various boundary tools (Ghazawneh & Henfridsson, 2013) to enable customization of the platform service for different digital environments, devices, and use cases. This discovery highlights the importance of partners as a

valuable resource for expanding the platform to global markets. Therefore, it is crucial for firms developing indoor positioning platforms to form, develop, and maintain a partner network if they intend to expand globally. However, the boundary conditions introduced by loose and tight couplings should be taken into account when strategizing on the platform openness, as research has shown implications on their effectiveness (Boudreau, 2010; Nambisan & Luo, 2021)

The concept of digital generativity facilitated innovative and creative ways of utilizing and expanding indoor positioning platforms in new global market segments. The results of this study suggest that a partner's innovation capability plays a critical role in the internationalization of such firms. Specifically, when a platform is open and equipped with tools for further development, partners can identify new opportunities (cf. Alvarez & Barney, 2007) and innovate novel ways to utilize the platform in foreign markets. This is especially important in the context of indoor positioning, which offers significant potential for diverse applications in various indoor environments.

Based on the above discussion we may conclude that digitalization characteristics, such as digital openness, digital affordances, and digital generativity of the platform are important for fostering international expansion. Hence, we propose:

Proposition 1. *The greater the emphasis on digitalization characteristics (openness, affordances and generativity) by the platform service provider, the higher their internationalization.*

The findings reveal that the classification of indoor positioning platform couplings into either loose or tight is not straightforward, as the couplings tend to change dynamically from loose to tight or vice versa. The findings reveal also that both loose and tight couplings provide benefits for the firm's international business activities. The study shows that loose couplings are effective for internationalizing the platform with limited resources, as loosely coupled partners possess specific knowledge of their customers and end-users, allowing them to customize the platform service to meet their specific needs. This is related to the fact that these partners possess specific knowledge of customers and end-users (cf. Nambisan and Luo, 2021; Weick, 1976), allowing them to tailor the platform service to their specific requirements. Conversely, consistent with Danneels's (2003) research, the study demonstrates that investment in tight couplings facilitates learning from partners and end-users' needs, enabling firms to better tailor their services and tools to support further internationalization. Additionally, the results suggest that forming tight couplings with large and reputable partners may generate new business opportunities and support further expansion into foreign markets. It may be concluded that for strategic and more long-term effects, a tighter coupling of the platform is justified, while a looser coupling benefits sporadic international expansion. Hence, we propose:

Proposition 2. *The tighter versus looser the coupling strategy of the platform service provider the greater the influence of digitalization characteristics (openness, affordances and generativity) on their strategic internationalization versus sporadic.*

Interestingly, the findings suggest that in the studied context, the role of couplings can be dynamic and change over time. The results indicate that loose couplings can sometimes evolve into tight couplings when a loosely coupled partner starts developing the platform service for new markets or customer segments. Similarly, it was observed that tight couplings may change to loose couplings when a partner gains proficiency in working on the platform, and there is no need for further changes within their industry or market. Therefore, the effectiveness of the platform service provider's coupling strategy is highly dependent on their customers'proficiency and resulting needs. If a tighter coupling is the aim of the producer, then a customer that prefers such approach is well aligned, but one that instead is keen on developing their business more freely on their own terms, may not be. From service provider point of view this is not necessarily bad, since sporadic opportunities may bring potential for new expansion possibilities that they would not otherwise attain. Hence, we propose:

Proposition 3. *The development of the customer requirements from weaker towards greater support will induce a need for the platform service provider for tighter coupling, or vice versa, which will either support the influence of producer's coupling strategy on strategic internationalization, or instead, foster sporadic expansion.*

This observation of dynamic changes in couplings provides additional insights that contribute to the understanding of the multi-dimensional nature of couplings, as previously observed in works by Danneels (2003) and Orton and Weick (1990).

6. Conclusions

This study makes several significant contributions. Firstly, it enhances our understanding of how platform providers operating in diverse markets, such as indoor positioning, can expand rapidly to global markets, which is crucial for platform firms as local markets for their services are often too small. Moreover, this study advances our knowledge of the internationalization of indoor positioning platforms, which operate in fast-growing and diverse markets where several different technologies are used to implement the service.

Secondly, this study sheds light on how the characteristics of digitalization (Nambisan and Luo, 2021) can facilitate rapid and extensive internationalization across various market segments, contributing to our knowledge on this topic. The key driver for internationalization was found to be the platform's openness, while digital affordances allowed for customization of the service to meet the needs of different foreign markets and industry segments. Furthermore, digital generativity led to new and innovative ways of serving new foreign customers.

Thirdly, the study enhances our understanding of loose coupling theory (Glassman, 1973; Orton and Weick, 1990; Weick, 1976) by demonstrating how platform providers can leverage both loose and tight couplings to expand their business globally. Furthermore, our study expands on the concept of the multidimensional nature of couplings (Danneels, 2003; Orton and Weick, 1990) by highlighting their dynamic role. Specifically, we found that in our studied context, couplings exist on a continuum, and their level of looseness or tightness can vary dynamically depending on the developmental needs of the partners.

References

Alvarez, S.A. & Barney, J. (2007). Discovery and creation: alternative theories of entrepreneurial action. *Strategic Entrepreneurship Journal,* 1(1-2), 11-26.

Boudreau, K.J. (2010). Open Platform Strategies and Innovation: Granting Access vs. Devolving Control. *Management Science.* 56(10), 1849-1872.

Brena, R.F., Garcia-Vázquez, J.P., Calván-Tejada, C.E., Muñoz-Rodriguez, D., Vargas-Rosales, C. & Fangmayer, J. (2017). Evolution of Indoor Positioning Technologies: A Survey. *Journal of Sensors.*

Danneels, E. (2003). Tight–loose coupling with customers: the enactment of customer orientation. *Strategic Management Journal,* 24(6), 559-576.

Dedes, G. & Dempster, A.G. (2005). Indoor GPS positioning-challenges and opportunities. IEEE 62nd Vehicular Technology Conference. 412-415.

Eisenhardt, K.M. (1989). Building Theories from Case Study Research. *Academy of Management Review,* 14(4), 532-550.

Fraccastoro, S., Ojala, A. & Gabrielsson, M. (2023) Technical, Strategic, and Cultural Bottlenecks of Born-Global-Digital firms. Proceedings of the 56th Hawaii International Conference on Systems Science.

Gabrielsson, M., Fraccastoro, S., Ojala, A. & Rollins, M. Digital Entrepreneurial Internationalizers: Definitions, Theoretical Implications, and Research Avenues. Proceedings of the 54th Hawaii International Conference on Systems Science.

Gartner (2021). Emerging Technologies: Revenue Opportunity Projection of Indoor Location Services. https://www.gartner.com/en/documents/4002627. Accessed 15 Feb. 2023.

Geotab (2020). History of GPS satellites and commercial GPS tracking. https://www.geotab.com/blog/gps-satellites/. Accessed 14 Feb. 2023.

Glassman, R.B. (1973). Persistence and loose coupling in living systems. *Behavioral Science,* 18(2), 83-98.

Ghazawneh, A. & Henfridsson, O. (2013). Balancing platform control and external contribution in third-party development: the boundary resources model. *Information Systems Journal,* 23(2), 173-192.

Hein, A., Böhm, M., & Krcmar, H. (2018). Tight and loose coupling in evolving platform ecosystems: The cases of Airbnb and Uber. Business Information Systems: 21st International Conference, BIS 2018, Berlin, Germany, July 18-20, 2018, Proceedings 21.

Hsieh, H-F. & Shannon, S. E. (2005). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research.* 15(9), 1277-1288.

Kallinikos, J., Aaltonen, A., & Marton, A. (2010). A theory of digital objects. *First Monday, 16*(6).

Kallinikos, J., Aaltonen, A., & Marton, A. (2013). The Ambivalent Ontology of Digital Artifacts. *MIS Quarterly, 37*(2), 357–370.

Karhu K, Gustafsson R, Lyytinen K (2018) Exploiting and defending open digital platforms with boundary resources: Android's five platform forks. *Information Systems Research*, 29(2): 479-497.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). Qualitative Data Analysis: A Methods Sourcebook. Sage Publications.

Nambisan, S. & Luo, Y. (2021) Toward a loose coupling view of digital globalization. *Journal of International Business Studies,* 52(8), 1646-1663.

Nambisan, S., Wright, M., & Feldman, M. The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. *Research Policy*, 48(8), 103773.

Ojala, A., Evers, N., & Rialp, A. (2018). Extending the international new venture phenomenon to digital platform providers: A longitudinal case study. *Journal of World Business, 53*(5), 725–739.

Ojala, A., Fraccastoro, S., & Gabrielsson, M, (2023). Characteristics of Digital Artifacts in International Endeavors of Digital-based INVs. *Global Strategy Journal.*

Ojala, A. & Lyytinen, K. (2022). How do entrepreneurs create indirect network effects on digital platforms? A study on a multi-sided gaming platform. *Technology Analysis & Strategic Management.*

Orton, J.D. & Weick, K.E. (1990). Loosely Coupled Systems: A Reconceptualization. *Academy of Management Review*, 15(2), 203-223.

Pettigrew, A.M. (1990). Longitudinal Field Research on Change: Theory and Practice. *Organization Science,* 1(3), 267-292.

Prol, F.S., Morales Ferre, R., Saleem, Z., Välisuo, P., Pinell, C., Lohan, E.S., Elsanhoury, M., Elmusrati, M., Islam, S., Çelikbilek, K., Selvan, K., Yliaho, J., Rutledge, K., Ojala, A., Ferranti, L., Praks, J., Bhuiyan, MZM., Kaasalainen, S., & Kuusniemi, H. (2022). Position, Navigation, and Timing (PNT) through Low Earth Orbit (LEO) Satellites:

A Survey on Current Status, Challenges, and Opportunities. *IEEE Access*.

Sanchez, R. & Mahoney, J.T. (1996). Modularity, flexibility, and knowledge management in product and organization design. *Strategic Management Journal,* 17(S2), 63-76.

Shapiro, C. & Varian, H.R. (1998) *Information Rules: A Strategic Guide to the Network Economy*, Boston: Harvard Business Press.

Swanborn, P. (2010). *Case Study Research: What, Why and How?* SAGE Publications Ltd.

Weick, K.E. (1976). Educational Organizations as Loosely Coupled Systems. Administrative Science Quarterly, 21(1), 1-19.

Wirola, L., Laine, T.A. & Syrjärinne, J. (2010). Mass-market requirements for indoor positioning and indoor navigation. 2010 International Conference on Indoor Positioning and Indoor Navigation.

Yin, R.K. (2009). *Case study research: Design and methods*. SAGE Publications.

Yoo, Y. (2012). Digital Materiality and the Emergence of an Evolutionary Science of the Artificial, in Materiality and organizing: Social interaction in a technological world (Eds. P.M. Leonardi, B.A. Nardi, & Kallinikos, J.). Oxford.

Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010). The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research. *Information Systems Research, 21*(4), 724–735.

Yoo, Y., Boland, R.J., Lyytinen, K., & Majchrzak, A. (2012). Organizing for Innovation in the Digitized World, *Organization Science, 23*(5), 1398–1408.

Zittrain, J. (2006). The generative Internet. *Harvard Law Review, 119*: 1975–2040.