Software Ecosystems: A Software Ecosystem Strategy Assessment Model

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ABSTRACT
Software companies and organizations increasingly open up their business to other software companies and as a consequence they find themselves in an ecosystem of software companies, developers and partners. These actors, and especially the software organization that is at the core of this ecosystem, are having difficulties in getting insight into this ecosystem and how their actions influence its performance. In this paper a model is presented that describes the key characteristics of a Software Ecosystem. The central hub of a Software Ecosystem can use data on these characteristics to its strategic advantage. This is demonstrated by the use of the model in a case study of a hub in a software ecosystem.

General Terms
Management, Measurement, Performance, Design, Theory.

Keywords
Business Ecosystems, Software Ecosystems.

1. INTRODUCTION
Over the last few decades a significant number of software companies have discovered that they can no longer develop an entire software product themselves and still fulfill all customers' demands. Customers increasingly demand new and more specific functionality, forcing software vendors to look to third parties, such as other software companies or single developers, to add these functionalities to their product. This development started with the desktop operating systems in the 80s, when other software companies started developing applications for operating systems like Macintosh and Microsoft Windows. In the mid 90s it became possible to write plug-ins for certain software products, in essence creating the possibility for other software companies or single developers, to extend a software product with new capabilities. Presently, all software companies are somehow involved in these networks of software companies that are gathered around a single platform, called Software Ecosystems (SECOs). Maybe one of the best current examples is the Apple iPhone SECO, where numerous developers can create applications for the iPhone and place them on a central marketplace, called the AppStore.

Conference'10, Month 1–2, 2010, City, State, Country.

In SECO research a few definitions already exist [3][14], we will use the definition of Jansen, Brinkkemper and Finkelstein [13]:

Software ecosystem: A set of actors functioning as a unit and interacting with a shared market for software and services, together with the relationships among them. These relationships are frequently underpinned by a common technological platform or market and operate through the exchange of information, resources and artifacts.

SECOs can be seen as a subtype of business ecosystems, an analogy first used by James F. Moore [16] in the early 90s describing a new way of looking at certain networks of businesses. These ecosystems basically consist of a number of things: the central hub, a platform and niche players [11]. The logic is that the central hub is the owner of the platform, and that niche players can use this platform to create value for themselves. In the Microsoft Windows SECO, Microsoft is the central hub, Windows is the platform, and other companies, or niche players, use this platform to create applications. As more software companies follow this example and open up their business to other software companies, more SECOs start to form. The problem that now exists for a lot of these companies is how they should manage such an ecosystem of software companies, developers, and partners. These actors, and especially the central hub and platform owner often have difficulties getting insight into their SECO and how their actions influence the entire ecosystem [3][12][13] and its performance. Literature from the business ecosystem domain provides a solid foundation, but it is not specifically aimed at the software market and as such is not completely applicable to SECOs.
In this paper the SECO Strategy Assessment Model (SECO-SAM) is presented that enables software producing organizations to assess the status of a SECO, and to assess the success of decisions taken in the past. The SECO-SAM consists of a model and a set of research tools. The SECO-SAM is applied in a case study, to illustrate its use. It was found to be useful by the case study participants.

The paper continues with the description of the research method in section 2. In section 3, related literature is discussed and in section 4 the SECO-SAM is described. In section 5 it is described how the SECO-SAM is applied to a case study. In section 6 observations and conclusions are provided.

2. RESEARCH QUESTION & METHOD
The objective of this research is to develop a model that can help companies get insight in the SECO they are in so that they can successfully manage their SECO strategy. As there is little literature available on software ecosystems and as it is a fairly

new topic, this research is exploratory in nature, which is reflected in the main research question:

What key defining characteristics can be used to describe a software ecosystem in order to support the central hub of the software ecosystem in its decision making process?

This research question will be answered using design science [10], where expert interviews are used in the construction process and a case study is done to evaluate the artifact in practice. The objective of design science is to create and evaluate an artifact that can solve identified organizational problems. For this research the artifact is the SECO-SAM.

The first step in the construction of the SECO-SAM was to perform a literature study of the relevant literature in business- and software ecosystems, part of which is described in section 3. Existing literature was used to construct the first version of the SECO-SAM. This version was then shown to several experts, who are active in a software product company that is a central hub in a young and developing SECO. Their input was used to evaluate the SECO-SAM. The results of the expert interviews are not described here, for the sake of brevity. The second version of the SECO-SAM was then used in a case study at the Open Design Alliance (ODA), the results of which can be found in section 5. The model served as the basis for a questionnaire that was presented to the niche players of the ODA SECO. The results of this questionnaire were then presented to the ODA in the form of a consultancy report. A final round of evaluation was then performed by interviewing several employees of the ODA and asking them about the usefulness and completeness of the results and hence the SECO-SAM.

3. ECOSYSTEM LITERATURE

An extension on Moore's business ecosystem theory is the research of Iansiti and Levien [11], who in their book on business ecosystems define a number of different roles that exist in business ecosystems: keystones, dominators and niche players. A keystone and a dominator are both hubs in an ecosystem. Where a keystone however creates and shares value with the rest of the ecosystem, a dominator seeks to extract as much value from the ecosystem, consequently destroying it. Niche players make up the rest of the ecosystem and they are all connected to the central hub. According to Iansiti and Levien [11] a niche player "acts to develop or enhance specialized capabilities that differentiate it from other firms in the network, leveraging resources from the network while occupying only a narrow part of the network itself. Niche players individually do not have broad-reaching impacts on other species in the ecosystem, but collectively they constitute the bulk of the ecosystem both in terms of total mass as well as variety". Hagel, Brown & Davison [9] further divide niche players (or participants as they call them) into influencers, hedgers and disciples. "An influencer is a niche player that commits early and prominently to one shaping strategy (or keystone strategy). A hedger develops its products or services to support multiple shaping platforms (or keystone platforms). A disciple commits exclusively to one shaping platform (or keystone platform)".

In these definitions one essential term is mentioned, being the ecosystem platform. According to Iansiti and Levien [11] an ecosystem platform is "a set of solutions to problems that is made available to the members of the ecosystem through a set of access points or interfaces". In SECOs, the platform is usually a software product, but it can also consist of software libraries which niche players can use to extract and create value, as can be seen in the ODA case study.

Business ecosystem health is an analogy from natural ecosystems research [18]. The term business ecosystem health was first used by Iansiti and Levien [11] to describe the performance of a business ecosystem. According to them, ecosystem health consists of the level of productivity, robustness and niche creation. These business ecosystem characteristics and their relationships can be seen in the domain model in figure 1.

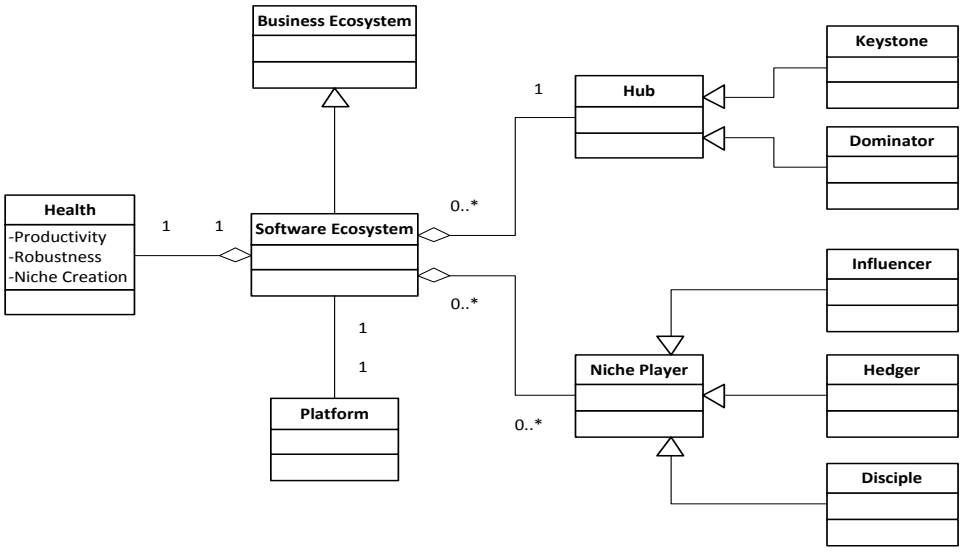

Figure 1: Domain model of the relationships between the currently existing terms in (Software) Ecosystems

4. SECO STRATEGY ASSESSMENT MODEL

The SECO-SAM defines key characteristics of a SECO that can be made quantifiable. The central hub of a SECO can then adorn these characteristics with data to gain insight into the SECO. Part of the SECO-SAM, i.e., the main characteristics of a SECO, is shown in figure 2. Going from top to bottom, the first part of the characteristics model shows a division that is based on literature in the public health sector [15]. In the same way that a person's health is influenced by a person's biology, lifestyle, environment and health care organization, so can SECO health be influenced by the SECO biology, lifestyle, environment and health care organization. This theory from the public health sector is used as it fits perfectly in to the ecosystem health analogy from Iansiti and Levien [11].

4.1 SECO Biology

In public health research, human biology is the basic biology of man and an individual's organic make-up [15]. The SECO biology consists of the **composition** and the **health** of a SECO. A SECO is composed of a hub, its surrounding niche players, their relationships and the platform that these actors use to create value. SECO health, which can be seen as the performance of the SECO, consists of productivity, robustness and niche creation [11].

4.2 SECO Lifestyle

The way in which a SECO moves and behaves is mostly governed by the provider of the platform, the SECO hub. Because of this, the SECO-SAM must be seen through its eyes. The lifestyle of a SECO is further divided into three levels, the strategic level, the tactical level and the operational level. These are the three basic levels in decision making [21] and they can also be used for decision making in SECOs. The SECO strategic level covers four key characteristics: SECO vision, platform strategy, stability and reputation management.

Westley and Mintzberg [23] state that "a vision can be broken down into three distinct stages: (1) the envisioning of an image of a desired future organizational state which (2) when effectively articulated and communicated to followers serves (3) to empower those followers so that they can enact the vision". In a SECO these followers are the niche players. A **SECO vision** enables niche players to see the desired future state of the SECO. A well-defined SECO vision can be a reason for niche players to join a SECO and in turn this might lead to higher niche creation and increased success for the SECO.

The SECO-SAM should be viewed from the perspective of one single hub with one single platform. The strategy for the SECO is, as a consequence, an extension to a **platform's strategy**. There are however some differences between the two [3]. In this research the term platform strategy (as opposed to product strategy) is used, as this is a more appropriate and much used term in software ecosystem literature. The theory behind product strategy can however be perfectly applied to SECO thinking. According to Kittlaus and Clough [14] a product strategy covers a time span of about one to five years in the future. According to them the product strategy should include the development or evolution of following items, during the time span mentioned before: product scope, i.e. the approximate functional scope of the product, target market, possibly segments, product delivery model, product positioning, business expectations, i.e. development of market share, sales, etc., budget and resources planning and roadmap planning. Corporate strategy and vision will be the foundation for the definition of the product strategy [14]. For a SECO, the SECO vision will be the foundation for the platform strategy.

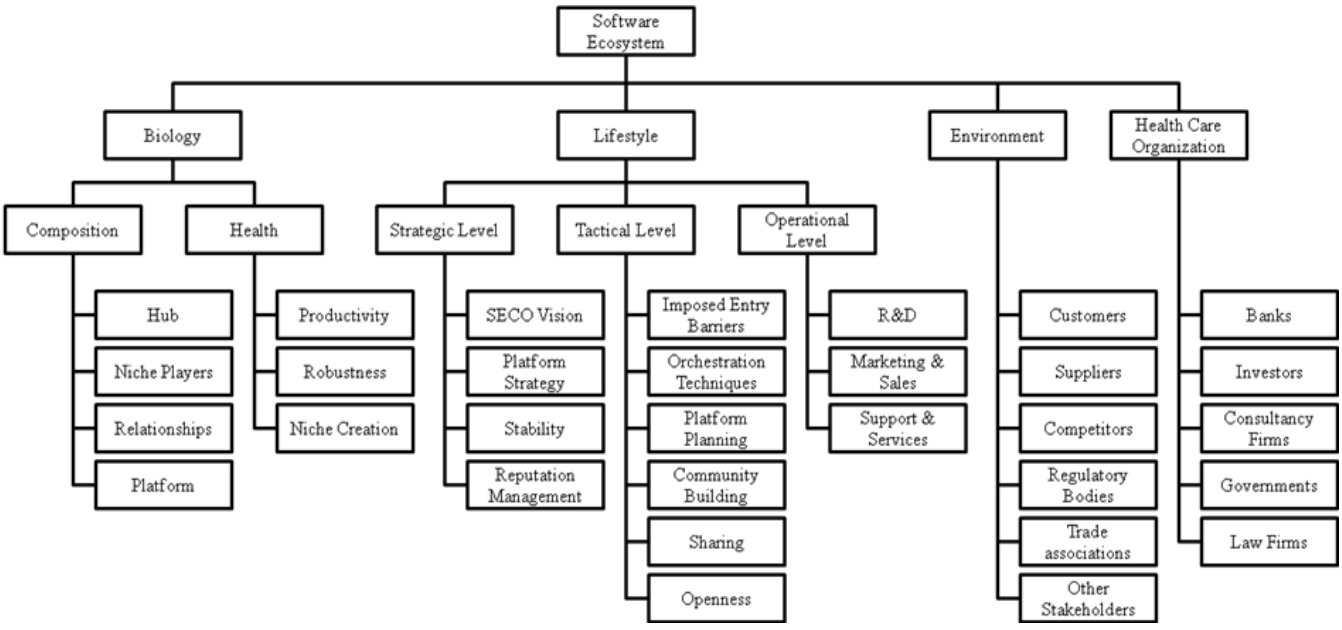

Figure 2: The Software Ecosystem Strategy Assessment Model

"Almost all evolved networks of interacting elements (from biochemical pathways to social networks) have their **stability** and function governed by keystones" [11]. This stability is enhanced by a keystone strategy. Keystone strategies shape and coordinate the ecosystem. The corporate vision and strategy need to have certain stability over time so that the employees of the company are reliably guided by them" [14]. This is the same for the SECO vision and platform strategy. Lack of stability in these areas might confuse niche players as they have no sense of direction. This in turn might be a reason for niche player to change to another (competing) ecosystem, which leads to lower niche diversity.

"The **reputation** that a business has can significantly impact its ability to forge strong knowledge generating and sharing relationships" [2]. "It can be agreed that organizations with strong reputations are better able to attract stakeholders and to develop more stable relationships with them" [5]. The previous statement indicates that niche creation can grow if the reputation of an organization is high. Bosch [3] also states that the reputation of the organization and/or platform plays a role in the success of a SECO. A hub must recognize the influence and importance of its reputation and it must try to manage this at a strategic level.

The SECO tactical level consists of the following key characteristics: Imposed entry barriers, orchestration techniques, platform planning, community building, sharing and openness.

The **imposed entry barriers** of a SECO are there to ensure that only the right companies can join the SECO. If entry barriers are too low, the stability of the SECO might decrease because of uncontrolled growth and loss of quality (in developers and the components they develop) and thereby the risk of an unhealthy ecosystem increases.

If the entry barriers are too high then innovation is at risk. Too many companies might be scared away by high entry barriers and they may flock to other competing SECOs, having a negative effect on niche creation. An example of an entry barrier is the application approval policy of Apple for the iPhone OS. The rationale behind this is that applications cannot contain inappropriate content or degrade the core-experience of the iPhone, in turn assuring quality, but it also leads to lower niche creation as developers are scared away by these imposed entry barriers. Choosing the right balance between quality and innovation is vital for ecosystem health.

Jansen et al. [13] state that "SECO Orchestration describes the arrangement, coordination, and management of actors and networks in a SECO. **Orchestration techniques** are generally used to improve a SECO, but can also be detrimental to a SECO, when the keystone player imposes too confining regulations. Examples of orchestration techniques are the setting of standards, introducing quality standards and certification programs, sharing of a SECO vision, and explicitly defining the boundaries of a SECO" [6]. Setting standards will make it easier and for niche players to develop components for the platform, in turn increasing productivity. Applying certificates and developer rules will make it clearer for the developers what is expected of him. This will in turn lead to higher product quality and higher innovation.

Platform planning is the SECO equivalent of product planning for ISVs. The main elements of platform planning in SECOs are thus the same: roadmap definition, release planning, and requirements management that for application software leads to functional specifications [14]. Each one of these processes must be performed with the SECO, and thus the niche players, in mind. "Companies that engage in successful platform planning realize benefits in many areas. They have greater ability to tailor products to the needs of different market segments or customers. The platform approach reduces the incremental cost of addressing the specific needs of a market segment or of an individual customer, enabling market needs to be more closely met" [19]. These three tasks can also be found in the software product management framework of Van de Weerd et al. [22].

Community building enhances robustness in a SECO, which is one of the key components of ecosystem health. Den Hartigh et al. [6] further drill down the notion of robustness into a number of measures and one of these measures was the connectedness of the niche players. The logic is that if companies have a higher connectedness, the ecosystem will be more robust. A keystone must seek to create a higher connectedness of its niche players. A Keystone must make it possible for its niche players to meet. In a SECO this can be done by (for example) creating developer forums or by hosting partner meetings. This is however only the first step. A keystone must further encourage its niche players to participate in these activities; it must not only build a community but also maintain it carefully.

"Whatever the view ascribed to a network organization, they all have in common the need to manage their members' knowledge so that their goals may be achieved with minimum effort" [20]. Knowledge **sharing** in an ecosystem is necessary to create innovation and higher production. "If a company is not open enough it may stifle innovation" [4], which is a key characteristic of ecosystem health. Sharing too much information, on the other hand, might lead to the loss of intellectual property. Seeing as how members in an ecosystem can sometimes change quickly to another SECO, so does its intellectual property. A hub must thus decide how much information he wishes to share.

In scientific research **openness** is seen in different ways [4]. The three most important terms when it comes to openness are: open standards, open formats, and open source. These are three unique terms but they all influence the level of openness of an organization. "Open standards make it possible to have a variety of interchangeable and interoperable products developed by different companies. They are instrumental to increase competition and, in the end, customer satisfaction. Open formats are open standards to store and transmit documents, information, and in general knowledge. Examples of open formats are HTML and XML. Open source is an approach to manage the development and distribution of software. Open source means that the user of a software program is able (free) to access the source code of the program, study it, change it, and redistribute it. This can be achieved using particular software licenses that grant the user these rights" [4]. An organization must choose the levels of openness it wants to have and it must realize that choosing a certain level of openness influences the health of the SECO.

The operational lifestyle is further divided into the following key characteristics: research & development, marketing & sales, and support & services. This division is made on the departments

that exist in most software development companies and it is based on [14] and [22].

The **R&D** department of a company is usually where new functionalities for the product or platform are designed and implemented. It is here that innovative products are developed. In a SECO a decision must be made how much of the R&D is done together with niche players. R&D is a key area in SECO health as low innovation leads to low ecosystem health. Niche players stating that the R&D department of the keystone isn't innovative enough might change to a different ecosystem where they do find the innovation they need to develop innovative products themselves.

The **marketing and sales** of the product or platform is not only important to the keystone player but also for the niche players. If the product or platform is not marketed or sold well, then the individual health of the niche players may suffer. If a keystone player is able to provide good sales support, then this will help increase robustness because it will improve profit margins for niche players as well as for the keystone.

Niche players need a good **support and services** department to develop their products. If the keystone is unable to quickly and correctly help the niche players develop the components for the products, the innovation and productivity of the niche players will suffer.

4.3 SECO Environment

The environment category includes "all those matters related to health which are external to the human body and over which the individual has little or no control" [15]. (Software) Ecosystems also have an environment in which they exist and over which they have little or no control.

Even though the keystone player has little influence on the outside world, it still is interesting to see what relation the SECO and its members have with the environment. In [17] Porter states: "The strategist, wanting to position his or her company to cope best with its industry environment or to influence that environment in the company's favor, must learn what makes the environment tick". If the environment has a negative impact on the SECO, then the keystone player can decide to change its lifestyle to cope with the negative impact of the environment. An example of this is the Microsoft Windows platform and the internet explorer browser integration. The European commission decided that Microsoft could no longer tie its web browser, internet explorer, to its Windows platform in Europe. This has led to a (minor) lifestyle change in that Microsoft decided to give users the possibility to choose between the most popular web browsers at installation of Windows [1]. The environment can be further divided into the following key characteristics: Customers, suppliers, competitors, regulatory bodies, trade associations and other stakeholders

Customers or buyers are one of most important, if not the most important, forces on a SECO. A small customer base (relative to competitors) or low customer satisfaction rates can be devastating to a company or SECO. If not satisfied, customers can, and will, change to a competitor. Buyers have significant power this way, also recognized by the five forces model of Porter [17]

Suppliers are another one of the forces of the five forces model of Porter [17]. A keystone in a SECO is highly dependent on its suppliers. If a supplier decides to change its strategy, or if a supplier falls away completely, this will have great effect on the entire SECO. If Oracle were to stop development and support for MySQL, a lot of MySQL database builders, and the SECOs they are in, would suffer deeply.

Another major influence in the environment of a SECO are the **competitors**. An example of losing out to competition is the smartphone operating system (OS) market where, according to [7], the Symbian OS and the Windows Mobile OS SECOs are losing market share to competitors (in the third quarter of 2009), mainly the iPhone OS and Android OS. These SECOs seem to be better at niche creation and productivity, by having central application marketplaces, resulting in healthier ecosystems.

"Ecosystems trigger social change. Social change always stirs up reaction from society, and almost always from government. It is crucial for the strategist to try to anticipate and manage the reverberations so that they are as supportive as possible of the ecosystem's success, and also to prevent them from being a reason to confiscate the gains if the ecosystem flourishes" [16]. This phrase of James Moore on business ecosystems shows the impact **regulatory bodies**, like governments, can have on ecosystems. The Microsoft example above is a perfect example of this.

Trade associations are described in [8] as: "organizations of business competitors, in a specific industry or business, that are interested primarily in the commercial promotion of products or services. Membership is usually held in the name of a business entity. Activities may fall into one or more of the following areas: business ethics, management practices, standardization, commercial (i.e., statistical) research, publication, promotion, and public relations". Because these trade associations can have significant influence in these areas, a hub must take them in to account as a significant part of the environment.

Other stakeholders, not mentioned in the characteristics above, fall under this category

4.4 SECO Health Care Organizations

"The health care organization consists of the quantity, quality, arrangement, nature and relationships of people and resources in the provision of health care. It includes medical practice, nursing, hospitals, nursing homes, medical drugs, public and community health care services, ambulances, dental treatment and other health services such as optometry, chiropractics and podiatry" [15]. It is these organizations that can improve a persons' health. For (Software) Ecosystems the health care organizations are all the means that a hub has to improve the health of its ecosystem. The health care organization can further be divided into the following characteristics: Banks, investors, consultancy firms, governments and law firms.

Banks and investors can inject money into the SECO and thereby improve the financial health of the SECO if the investments are used wisely. They can be compared to doctors prescribing medicine. If used wisely they can improve health in a significant way.

Where **governments** can take on the role as regulatory body (as seen in section 2.3.4), governments, whether they are local or (cross-)national, can also aid companies in doing business by providing subsidies, loans and other forms of financial aid. In

this sense, the government can be seen as a health care organization, and must therefore be mentioned separately here.

Consultancy firms can have a positive effect on the lifestyle of an organization by giving advice, thereby improving the health of a SECO.

Organizations can sometimes be involved in certain legal issues, albeit with their competition, customers, governments, etc. Losing these legal issues can be detrimental to the SECO. **Legal firms** can help a hub and a SECO overcome its legal issues, thereby improving the health of the SECO.

5. OPEN DESIGN ALLIANCE

The Open Design Alliance is an organization that promotes open standards in CAD formats, in particular the dwg file format. Their platform consist of a number of software libraries, which their members (niche players), can use to create technical graphics applications. The ODA has several membership levels and each level comes with different costs, rights and privileges. The membership types are:

- Educational member: These members can use the ODA libraries for research and other projects within educational institutes.
- Associate member: Can use the binary ODA libraries in-house but cannot distribute them.
- Commercial member: can distribute 100 copies of the binary ODA libraries per year.
- Sustaining member: can distribute an unlimited number of copies of the binary ODA libraries each year.
- Founding member: have an unlimited distribution license, have access to the source code, and can be involved in the management of the ODA.

Except for educational members, all members have to pay an annual fee to retain their membership, depending on their membership level.

5.1 ODA Questionnaire

The SECO-SAM was applied to the SECO of the Open Design Alliance (ODA), a software producing organization, as part of a case study. The SECO-SAM serves as a basis for a document study, interviews, focus groups or a questionnaire. At the ODA a questionnaire was used to get insight into the ODA SECO. The questionnaire was sent to all the 1150 members of the ODA, of which 258 responded, giving a response rate of 22.3%.

The questionnaire consisted of three parts. The first part was intended to get general information about the (types of) members and the composition of the ODA SECO. The second part is the main part of the survey and was intended to get a better insight into the ODA lifestyle. The third part of the questionnaire asked some questions about the environment the ODA is in. Below the results will be discussed.

In this first part of the questionnaire questions were asked regarding the composition of the SECO; the size of the members' organizations, the industries in which they are active, the countries they are from, etc. From these questions a main group of niche players was deducted. It was found that the majority of the ODA members are small companies, having a low level membership, using only a small part of the platform, which are based and active in either North America or Western Europe.

The second part of the questionnaire was based around the lifestyle topics as they existed in the revised SECO-SAM. On four of these topics (SECO vision, orchestration techniques, platform planning and marketing & sales) no questions were asked, simply because they were not relevant to the ODA SECO. Even though the ODA has no clearly stated vision or strategy, some questions were asked about the direction the ODA takes. These questions were more related to strategy then they were to vision, so it was chosen to omit this lifestyle topic.

The ODA is a different kind of ecosystem than most SECOs because its members do not directly contribute to the platform. The members are allowed to use the platform and are in this way more or less customers. Indirectly however they do contribute to the SECO and in this way the ODA SECO is different than the standard ISV. Because of this situation, the ODA has no clearly stated developer rules, certification programs or standards, hence no questions were asked regarding this topic.

The last two topics that were not used in this questionnaire were platform planning and marketing & sales. No score could be calculated for the platform planning process because the ODA currently does not directly involve its members in this. When asked if the members wanted to be included in some of the platform planning processes, very low scores were obtained, indicating that there is no interest from members to be included in the platform planning process in the future.

No marketing and sales questions were asked, as the ODA does not have a marketing and sales department. When asked if the ODA members wanted the ODA to start marketing the ODA platform and the products of its members, 90% of ODA members responded negatively.

On all the other lifestyle topics questions were asked. For each topic a number of questions were asked, ranging from one question to five questions. All these questions had a five point Likert scale (strongly disagree to strongly agree). For each question a correlation analysis and a reliability analysis was performed to be able to aggregate the scores if the correlation and reliability was high enough. The correlation had to be significant at the 0.05 level and the reliability had to have a Chronbach's alpha of more than 0.60. Normally for scientific use, the reliability cutoff would be 0.80 for Cronbach's alpha, but as these results are mainly used for the consultancy report for the ODA a more lenient cutoff score was chosen.

If and when the questions had a high enough correlation and reliability they would be aggregated and divided by the number of questions to get an overall score for that particular topic. This number would then range between 1 and 5, 5 meaning that all members strongly agree that the ODA does a good job, 1 meaning that all members strongly disagree that the ODA does a good job, regarding that specific lifestyle topic.

The scores for the individual lifestyle items are visualized in figure 3. As the scores are based on answers that have a 5 point likert scale, where three is neutral, a score above three would be considered good, and a score below three is considered bad.

What can be seen is that community building and openness and sharing have scores below three. Most members answered that the ODA did not do enough to let them connect to other

members. Even though a forum does exist, members would like to see the ODA encourage its members more to participate. Furthermore the members stated that they would like to see something where they can suggest ideas for new requirements/products. Finally they stated that they would like to see a better bug management system where all members can better participate in.

Another heard concern was the documentation the ODA provides to its members. Even though the members agreed that the support staff is able to help them in a correct way, the documentation is lacking, according to some.

The highest scores are for strategy and R&D. This implicates that the members think that the ODA is good at its core business. Members state that they can find themselves in the strategy that the ODA has, and that the ODA does a good job of developing the platform.

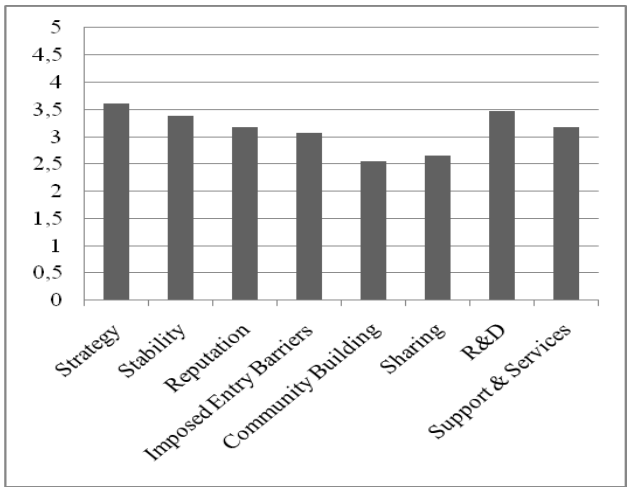

Figure 3: ODA Lifestyle Scores

In the last part of the questionnaire a number of questions were asked regarding the environment in which the ODA operates. The ODA members are mostly active in the CAD-sector and therefore a number of questions were asked regarding the developments in this sector and the competition in this sector. As with the first part of the questionnaire, these questions were merely intended to get simple percentages.

In table 1 the evaluation results are summarized. The questions on the left side are based on the main research question, found in section 2 and the right side shows the answers to the questions.

Table 1: Evaluation of the ODA case study

Does the ODA have a better insight into its SECO?	Yes, the ODA now has a good overview of its members, their size, where they come from, what their main group of niche players/members is, what parts of the platform they use, etc.
Have the key defining characteristics of a SECO been made quantifiable to the ODA?	Yes, the report of the questionnaire results shows the ODA the specific areas in which they were performing above and below average, and in effect showing the areas the ODA needs to focus on.
Has the use of the SECO-SAM helped the ODA to support them in their strategic guidance?	Probably, the ODA can use the results of the questionnaire to make better informed decisions as they now know what specific areas to focus on. If these decisions have a good effect on the health of the SECO is yet to be seen however.

6. CONCLUSIONS AND DISCUSSION

Software companies and organizations increasingly find themselves in a SECO or see that there are significant advantages in creating or joining in one. This paper describes a model that can be used as a tool for strategic guidance in such a SECO. The model was used in a case study at the ODA, which deemed the results of the questionnaire as very useful.

There are however a few limitations to this research, one of which is the external validity. Replicating the results of the implementation of the SECO-SAM in several case studies is necessary to ensure external validity. In this research only one case study was performed, the ODA case study. This was mostly because of time and resource issues. It is therefore hard to generalize the case study findings to other SECOs. Even though the results of the ODA case study showed promising results, there is not yet any assurance that the SECO-SAM is complete and useful for all types of SECOs. The SECO-SAM needs to be applied at different kinds of SECOs to be able to create a complete and useful model for all types of SECOs. The current SECO-SAM can thus be used as a basis for more case studies.

A second limitation of this research was that no research was done into the importance of each of the characteristics. It might be so that community building has a higher influence on the success of a SECO than the implemented entry barriers. One such example of this is the Apple iPhone ecosystem, where Apple has applied an approval policy as an entry barrier. Often complaints are heard from the developer world about this approval policy. On the other hand Apple is praised for building a strong community for its iPhone ecosystem. These developments hint at the possibility of community building having a greater effect on ecosystem success than entry barriers. As no real research is done in this area, these statements cannot yet be validated. New research can address the importance of each characteristic and add levels of importance to each of the characteristics in a new SECO-SAM.

A limitation of the SECO-SAM itself is that it is a broad model, covering a wide variety of characteristics. Typically, it will be impossible to research all characteristics of a SECO, creating an incomplete data set to base strategic decisions on. The SECO-SAM was used to create a questionnaire in the ODA case study, but in other cases can lead to series of interviews, case studies of multiple niche players, or even studies of sales rates of a platform product. The ODA has members all over the world and it was therefore not possible to visit different members and organize interviews with key people in the SECO. Because of this, one person of each member had to provide answers to questions regarding a wide variety of topics. Some of these members also indicated that they did not have the knowledge required for the questionnaire. Because they did not have this knowledge, for some topics high numbers of non-responses were

found. If the SECO-SAM is used for other research, attention must be given to obtaining information from the key sources in the SECO.

Because the SECO-SAM covers a broad spectrum of characteristics (especially for the lifestyle items) for SECOs, each of these characteristics can serve as the basis for further research. One example is the platform planning characteristic. Platform planning, as explained in section 4.2, covers the four basic processes in software development: Portfolio management, roadmap definition, requirements management and release planning. These processes are performed differently in SECOs, but how they are specifically different is not yet known, and no good SECO platform planning methods exist currently.

Another opportunity for future research is niche player ecosystem participation. The SECO-SAM, as described in section 4, must be seen from the hub's eyes. It is developed for the central hub to get information on its ecosystem and its lifestyle. It can use this information to become more innovative, to attain its niche players and to attract more niche players, in essence to create a healthier ecosystem. Not a lot of research however is done in ecosystem participation for niche players. Hagel et al. [3] describe a number of different niche players, and a possible strategy they can have for choosing a SECO to participate in. These strategies are however only briefly described and more research must be done in this area. Developing SECO adoption or participation strategies for niche players might help niche players in choosing the right SECO. Such strategies can describe the entry barriers as seen from the niche player, e.g. the niche player might not want to join a SECO when their strategies do not align. The SECO or platform strategy in that case would be an entry barrier, as seen from the niche players' perspectives.

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