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# PROJECT MANAGEMENT SUPPORT SYSTEMS IN THE SAAS MODEL IN THE ACTIVITY OF VIRTUAL ORGANIZATIONS

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## SYSTEMY WSPOMAGANIA ZARZĄDZANIA PROJEKTEM W MODELU SAAS W DZIAŁALNOŚCI ORGANIZACJI WIRTUALNYCH

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**Abstract:** Nowadays, the Software as a Service model is an increasingly popular method of acquiring and using IT systems such as project management support systems. The SaaS model consists in making IT systems available in the Internet space for a fee, which users can use online. The aim of the article is to analyse the possibilities of using project management support systems offered in the SaaS model in the activities of a virtual organization. The article introduces virtual organizations, emphasizing their features, structure and the role of IT technology in their functioning. The next section presents the general characteristics of the SaaS model and highlights the benefits and risks of using PMS systems in the SaaS model. Then, various conditions related to the purchase and use of PMS systems were signalled in the form of a service supporting the activities of a virtual organization. Finally, some PMS systems available in the SaaS model that can support the activities of domestic and international virtual organizations were listed.

**Keywords:** project management systems, SaaS, virtual organization.

**Streszczenie:** Współcześnie coraz popularniejszym sposobem nabycia i użytkowania systemów informatycznych, takich jak systemy wspomagające zarządzanie projektem, jest model *Software as a Service*. Model SaaS polega na odpłatnym udostępnianiu w przestrzeni internetowej systemów informatycznych, z których użytkownicy mogą korzystać w trybie *online*. Celem artykułu jest analiza możliwości zastosowania systemów wspomagających zarządzanie projektami oferowanych w modelu SaaS w działalności organizacji wirtualnej. W

artykule na wstępie omówiono organizacje wirtualne, podkreślając jej cechy, strukturę i rolę technologii IT dla jej funkcjonowania. W dalszej części przedstawiono ogólną charakterystykę modelu SaaS oraz podkreślono korzyści i zagrożenia związane z użytkowaniem systemów PMS w modelu SaaS. Następnie zasygnalizowano różnorodne uwarunkowania związane z nabyciem i użytkowaniem systemów PMS w formie usługi do wspomagania działalności organizacji wirtualnej. W końcowej części pracy wymieniono niektóre systemy PMS dostępne w modelu SaaS, które mogą wspierać działalność krajowych i międzynarodowych organizacji wirtualnych.

**Słowa kluczowe:** systemy zarządzania projektami, SaaS, organizacja wirtualna.

## 1. Introduction

The dynamics of changes in the environment (increased competitiveness, globalization, progress in IT technologies) influences transformations in the organization and the functioning of modern enterprises. Currently one of the important market trends is the virtualization of enterprises, the effect of which is the transformation of the traditional structure and a redefinition of enterprise processes towards multi-stakeholder cooperation in the form of a virtual organization. A virtual organization is a group of various specialized entities undertaking temporary cooperation to achieve a specific goal (usually of an economic nature). The forecasts and predictions of management theoreticians and practitioners indicate that traditional enterprises will evolve towards virtual organizations in the near future. Example of contemporary virtual organizations can be training companies, consulting companies, entities established for the implementation of a specific project (e.g. financed from European funds), etc.

Geographically dispersed entities that establish cooperation within a virtual organization must use a variety of information and communication technologies (ICT) that enable partners to both, share resources and jointly implement business processes. Project management support systems are an important tool supporting the activities of a virtual organization. These types of systems facilitate, first of all, planning, organizing (assigning tasks to co-operators), monitoring and controlling activities (performing and accounting the assigned tasks) of a virtual organization. Nowadays project management support systems can be purchased and used by various entities (including virtual organizations) in the form of services available in cloud computing under the SaaS model (Software as a Service). The aim of the article is to analyse the possibilities of using the project management support systems offered in the SaaS model in the activities of a virtual organization. In order to achieve this goal, the model of virtual organization was initially outlined. Then the SaaS model was discussed along with its benefits and limitations, and the functionality of project management support systems was presented. Further on, the conditions for the use of project management support systems provided in the

SaaS model in the operation of a virtual organization were indicated. Moreover, the stages of analysis and assessment of project management support systems properly adjusted to the needs of a virtual organization were presented. The final part of the article presents selected project management support systems offered in the SaaS model, which can be useful for supporting the activities of virtual organizations.

## 2. The concept and essence of a virtual organization

The concept of virtual organization was first introduced by Mowshowitz in 1986. The concept of a virtual organization was dynamically developed in the following years, although the authors used different nomenclature (e.g. virtual enterprise, virtual corporation or network organization) to describe this specific form of activity. The virtual organization model is a specific result of the synthesis of various management methods and concepts, as well as advanced information and communication technologies. The basic definition of virtual organizations (VO) can be fairly simple: organizations and individuals that dynamically inter-connect in order to share and use resources by means of temporary alliances (Cretu, 2012). In turn, Askarzai defines a virtual organization as a type of temporary or permanent organization with geographically and time-dispersed members (individuals, departments or organizations) (Askarzai, 2013). Culo points out that a virtual organization is a collection of geographically distributed, functionally and/or culturally diverse entities that are linked by electronic forms of communication and rely on lateral, dynamic relationships for coordination (Culo, 2016).

A virtual organization (VO) is created by independent, professional and often dispersed economic entities (e.g. entire enterprises or their separate parts, institutions, natural persons) that consolidate their resources and establish temporal cooperation to achieve a specific goal. The main reason for participation in a virtual organization is the lack of the potential of a particular entity to achieve the assumed goal on its own (e.g. client's order). The effect of cooperation within the organization is the possibility for individual entities to obtain new sources of income and access to new markets, as well as to increase their knowledge assets. A virtual organization as a flexible form of cooperation between relatively equal, mutually trusted and loyal entities is oriented towards achieving a goal (usually economic). The goals and intentions of the virtual organization should be known and accepted by all participants of the virtual organization.

The structure of a virtual organization (the number and type of entities constituting it) results directly from the purpose for which it was established (e.g. the type of order placed by the client or clients). A virtual organization has a flat and process-oriented structure that fluctuates as a result of changing client/s needs. The execution of the order usually results in the collapse of the virtual organization and each of its entities returns to its original activity. The emergence of a new market

opportunity may cause the reconnection of previously operating entities or the generation of a new constellation of entities making up a virtual organization.

Due to the use of information technology as the basic binder, a virtual organization can associate partners from different countries or continents, leading to global economic activity. The main features of a virtual organization include (cf. Burma, 2014; Burn, Marshall, & Barnett, 2002; Larsen & McInerney, 2002):

- a group (network) of autonomous, professional, geographically dispersed, complementary and voluntarily cooperating entities,
- high dynamics and flexibility of functioning (smooth roles of VO participants),
- openness to any changes (opportunities) of the environment,
- focus on achieving the basic goal (client's order),
- lack of formalization in the field of cooperation between entities,
- building on the combined and complementary skills, abilities and knowledge of partners,
- concentration of entities (participants of VO) on their key competences,
- acting as a uniform organization in relation to clients,
- operating mainly on intangible resources (in the absence of own material components of VO),
- effectiveness of implemented processes (optimization of the value chain) and innovation of the products/services provided,
- active use of information and communication technology,
- the validity of trust and mutual loyalty between the partners creating the VO.

In the case of a virtual organization, there is a departure from the traditional, rigid and clearly defined structural form of the enterprise, towards entering into inter-organizational relationships established to perform specific economic tasks within the assumed period of time. In the flat and flexible structure of a virtual organization, the following can be distinguished:

- integrator – who develops a strategy for the organization and operation of IA, selects cooperating entities for cooperation and coordinates their work, is responsible for all tasks related to customer service (acquisition and delivery of the product manufactured by IA to the recipient) and settles all financial transactions;
- cooperating entities – which are selected by the integrator according to their specialization and competences as well as the price/quality ratio, their number depends only on the specificity of the economic goal being pursued (client's order).

The functioning of a virtual organization relates to all its behaviour and adaptation activities resulting from the changes taking place in the surroundings or inside of the VO. All processes carried out in a VO are characterized by dynamics and permanent evolution in order to increase the functional and organizational effectiveness, which will allow for better meeting the requirements and needs of current and future clients. The activity of a virtual organization is based on proper knowledge management, and in particular on the conversion of knowledge into effective and efficient processes which allow a VO to generate more perfect (innovative) products. The result of a VO

activities is a ‘knowledge-intensive’ product (based on specialist knowledge) and a ‘virtual’ product (created together with the client and meeting their special needs). Thus, the ability to effectively and efficiently use the knowledge of the community of cooperating entities is a decisive factor for the success of a virtual organization.

Due to the variability and uncertainty of the environment, the ICT used in a VO should be flexible and undergo continuous improvement processes. Properly selected and optimally used ICT is primarily meant to influence the efficient and effective operation of both the entire virtual organization and its individual partners. Table 1 distinguishes two types of technologies used in virtual organizations, i.e.:

- technologies supporting operational activity – various ITC solutions and measures dedicated primarily to cooperating entities,
- technologies supporting the management of the operations of a virtual organization: these are various types of IT systems dedicated mainly to the integrator responsible for the operation and development of the VO, but they can also be used by individual (authorized) cooperating entities.

**Table 1.** Types of Technologies in a VO

<b>Types of Technologies in a VO</b>
<b>Technologies supporting VO operational activity</b>
<b>Technologies supporting the communication</b> – ICT tools and resources enabling direct or indirect implementation of communication processes, taking place between the parties grouped under the VO (e.g. suggestions, comments, queries, data and documents sending and exchange etc.). It houses the various electronic communication systems (e.g. e-mail address and message routing systems, chat, messengers, Internet telephony, teleconferencing, videoconferencing, e-fax service, various types of tools searching and indexing, software agents, etc).
<b>Technologies supporting the information and knowledge management</b> – information technology tools and resources for creating, organizing, storing, transferring, sharing and use of data and information among the entities forming a VO. These include office suites (OS), document management systems (DMS), blogs, wiki technology, portals, forums, e-learning, electronic bulletin boards, transfer and share file systems (including multimedia such as podcasts).
<b>Technologies supporting the collaboration</b> – information technology tools and resources used for the design, standardization, automation and control of flow processes (or tasks), which takes place through the allocation, scheduling and execution of work by the various partners, together with their associated activities of collecting, processing, archiving and transmission of certain terms of the form and the type of documents. Electronic job logs and fixtures, project management software (PMS) and workflow systems (WS), <b>project management systems (PMS)</b> and workflow systems (WS), groupware systems (GS) and business process management (BPM) can be highlighted among them.
<b>Technologies supporting the VO activity management</b>
<b>Transaction Processing Systems</b> – performing tasks of registration of primary and secondary economic processes taking place in the VO (these are often ERP systems)
<b>Business Intelligence</b> – performing analysis function and activity control of a VO and supporting planning and decision-making processes in the frame of a VO activities.

Source: own elaboration based on (Bajdor & Dziembek, 2015).

The cooperation of the business units included in the virtual organization (often operating in different locations) is based on the active use of information and communication technology which is a factor that binds economic units together within a VO, creating conditions for low-cost and uncomplicated cooperation in the global network environment. Various IT tools and measures activate a virtual platform enabling the VO to both implement business processes and actively shape its organizational structure.

### **3. An outline of the project management software**

Currently there are many IT systems supporting project management on the market. The increasing number, better quality and attractive possibilities of purchasing and using this class of systems contribute to the popularization of their use in the everyday work of project managers. According to Kundu et al., project management software is a term covering extensive types of software, including estimation and planning, scheduling, cost control and budget management, resource allocation, collaboration software, communication, quality management and documentation or administration systems, which are used to deal with the complexity and different aspects of large projects (2015). Marti et al. (2005), stated that project management software is designed to make the job of a project manager easier and more efficient, providing applications to aid in planning, to manage project costs, and to track activities and monitor schedules. According to Ahmad and Laplante, software project management involves those techniques used to identify, measure, and control various aspects of a software project throughout its life cycle. Many different software project management tools are used by managers to manage and support these activities by providing a means for planning, executing and controlling the project (2007). ProjectManagementSoftware.com, define project management software as any software solution that allows an individual or a team of people to track a project from its conception to its launch. This type of software typically provides project managers and other team members with a single access point to a wealth of pertinent information, including the scheduling of resources, budget management, time management, task assignments, quality control, bug/issue reports, documentation, and collaborative tools. The goal of project management software is to increase efficiency by making the project development cycle more transparent for all involved team members.

PMS (Project Management Software) systems can be modules of ERP systems or function as autonomous applications (with the possibility of data export/import). Kundu et al., summarized the most important functions of PMS systems, i.e. Scheduling Project Portfolio, Management Resource, Management Document, Management Workflow, Reporting and Web Based (accessed through internet). According to Spalek (2011), project management support systems allow users to implement such activities as:

- project portfolio management,
- creating a hierarchical list of tasks,
- task deadlines based on dependent tasks,
- cost-setting tasks,
- defining the project calendar,
- conducting risk analysis,
- project progress tracking (percentage of completion, cost tracking, monitoring and notification),
- resource allocation (assigning and balancing resources),
- user work configuration (parallel work, remote work, different authorization levels),
- graphical presentation of data (charts: Gantt, CPM),
- communication and sharing of documents (e.g. contact database, forums, attaching files, etc.).

The most important functions of project management support systems, each with a short description, are presented in Table 2.

**Table 2.** The most important functions of project management support systems

Function	Description
1	2
Task Scheduling	Task scheduling refers to the assignment of start and end times to a set of tasks. This feature lets software project manager track important project milestones and note who is responsible for each task.
Resource Management	This feature lets the software project manager organize and trace requirement details to ensure that proper resources are committed to the project. The software project manager can establish information relationships between multiple documents, assign attributes to the information, such as task assignment, priority and status, and change these over time to reflect changes in the project.
Collaboration	Collaboration enables both structured and free-flow sharing of knowledge and best practice. It includes project status reports that are accessible via a Web page, integrated e-mail or discussion boards.
Time Tracking	Time tracking allows recording, analysing and reporting associated with project working routine. Software project managers can use the time tracking feature to manage employee timesheets and expenses, calculate salaries, prepare project estimates, and generate invoices based on personnel or client work rates.
Estimating	The estimate feature allows the project manager to generate, manage, and validate estimates of effort for a wide variety of projects. It evaluates the project plan, project requirements, information about working environment and others.
Risk Assessment	Risk assessment helps the software project manager in identifying and planning for potential project risks. It could also help the software project manager to describe the various risk factors and how to score them.
Change Management	This feature lets software project manager control schedules, resources, and deliverables of project. It can manage the impact that changes have on project objectives, and it allows software project managers to trace changes to see how each change affects multiple other requirements.

Table 2. cont.

1	2
Project Analysis/ Reporting	It is an analysis of product, process, person or organization related project development effectiveness by Gantt, PERT, CERT or other custom formats that suits the organization.
Document Management	It enables managers or necessary project members to customize, share, distribute, recover, authenticate, secure and also manage versions of the documents.
Communication Tools	Most software project management tools provide integrated e-mail (or others) notification to keep team members informed of the current status such as defects, change in documentation issues and requests, and other related issues. These tools constitute the foundation for collaborative activities.
Process Development Method	With this feature standardized scheduling of tasks can be implemented. The project manager can manage various tasks or activities during product development process using these methods.
Portfolio Management	Portfolio Management feature helps the project manager manage multiple projects and allocate resources accordingly.
Access Control	Controls access to the resources of the software tool to authorized users and restricting access to unauthorized users.
Licence	Software project management systems can be open source or licensed.

Source: (Cicibasi, Unal, & Demir, 2010; Norita & Laplante, 2006).

Similar functions are present in both commercial and free PMS systems, which are now increasingly used not only by large but also by medium and smaller enterprises, both for small and complex projects. PMS systems, by integrating processes, people, goals, strategy and technology, can significantly affect the success of implemented projects and the achievement of goals. Nowadays, the popularity of cloud computing means that a significant part of PMS systems is offered as a service (SaaS model).

#### **4. The SaaS model as a form of acquisition and use of project management support systems for virtual organizations**

Basically, the activity of each virtual organization consists in the implementation of various types of undertakings and projects. In a dynamic, demanding and competitive market, finding and winning a client's order requires proposing a specific value added for the recipient, which requires effective communication with the recipient, flexibility and innovation as well as good work organization and the efficient implementation of often complex tasks and processes within the project. Striving to improve project management processes in a virtual organization may increase interest in the acquisition and use of systems facilitating the planning and implementation of projects performed as part of network cooperation between entities. The use of project management support systems makes it easier for a VO integrator to identify, analyse, evaluate and control the entity/team assigned and responsible for the implementation of a given task within the network. PMS tools



can also influence the effective motivation of partners by a VO integrator, increasing the effectiveness of the cooperating partners. It should also be emphasized that the complexity of the project implemented under the VO usually generates a significant amount of documentation and results in the need for the systematic monitoring and control of the project status, which makes efficient and effective project management difficult without the use of IT tools such as PMS systems.

The development of IT contributed to the creation and development of a new form of purchasing and using PMS systems, i.e. the SaaS model (Software as a Service). The SaaS model is an alternative to the traditional method of acquiring and operating IT systems based on the recipient's own resources (the so-called on-premise model). Sääksjärvi and Lassila define the SaaS model as on-line access (regardless of time and location) to a remotely managed software server that can be operated simultaneously by a greater number of independent users (clients, subscribers). By offering attractive application fees and ensuring a steady flow of new and innovative software capabilities, it enables to obtain value added by recipients (Lassila & Sääksjärvi, 2005). A synthetic definition is presented by Kulkarni, Gambhir and Palwe, who state that SaaS is a model of software deployment where an application is hosted as a service provided to customers across the Internet (Kulkarni, Gambhir, & Palwe, 2012). The article assumes that Software as a Service (SaaS) is a business model for the delivery and sale of applications and related services used by software producers, which offers customers the possibility of remote (via the Internet) operation of the IT system without the need to purchase a license, using subscription payment methods.

The use of the SaaS model excludes the need to purchase and maintain the development of the hardware (server) platform belonging to the recipient, because the application is located in special Data Centers belonging to the software supplier (or a cooperating entity). In the SaaS model, the supplier takes full responsibility for the proper functioning of the application (i.e. they are responsible for installation, modification, technical support, servicing and software availability). To use the application in the SaaS model, only computers with Internet access are required. The interface between the client and the software used is essentially a web browser. Access to the application and the related services takes place by entering a web address and completing the user's data along with the assigned password.

In the SaaS model, partners grouped in a virtual organization equipped with an appropriate IT infrastructure can use PMS systems on-line, for which they pay fees, the amount of which is usually determined by the number of users, operating time and the functional scope of the used application. PMS systems in the SaaS model can provide many benefits to entities grouped in IA, but this form of software use is also associated with certain threats, which are presented in Table 3.

In general, PMS systems in a VO are meant to facilitate the creation of an environment of efficient and effective cooperation of all entities in order to implement the project (client's order), disregarding spatial, time and organizational constraints. The ephemeral nature of virtual organizations makes it difficult to clearly describe

**Table 3.** The most important functions of project management support systems

Type	Benefits associated with the use of PMS system in SaaS model	Risks associated with the use of PMS system in SaaS model
1	2	3
Strategic	<ul style="list-style-type: none"> <li>– concentration of VO partners and integrator on their key competences,</li> <li>– increasing the flexibility and efficiency of VO activities,</li> <li>– support for global and mobile VO activities;</li> <li>– access of VO partners to technology that facilitates competition and obtaining orders on new markets,</li> </ul>	<ul style="list-style-type: none"> <li>– partial reliance of a VO on an external PMS supplier,</li> <li>– lack of full control of the VO Integrator over the data collected in the PMS system and the possibility of their leakage (e.g. the risk of incomplete deletion of data in PMS systems) or the loss of critical information resources preventing or hindering the implementation of strategic goals,</li> </ul>
Organizational	<ul style="list-style-type: none"> <li>– quick and easy access of VO partners to the PMS system (along with the service package),</li> <li>– the use of the PMS system is independent of the geographical location of the VO partners,</li> <li>– the ability to easily share information and knowledge gathered in the PMS system,</li> <li>– ease of use of the PMS system by VO partners (the interface is a web browser), which shortens the implementation time,</li> <li>– transferring the responsibility for the functioning of the PMS to the supplier,</li> <li>– the ability to dynamically adapt the PMS system to the current needs of VO,</li> <li>– the possibility of standardizing and simplifying the organization of processes in a VO,</li> <li>– the possibility of short-term operation of the PMS system by the VO (use depending on the time of order completion),</li> </ul>	<ul style="list-style-type: none"> <li>– Internet network failures that prevent access and use of the PMS,</li> <li>– incomplete possibilities of adapting the PMS system to the needs of a VO,</li> <li>– possible legal problems (different regulations in different countries, unfavourable provisions in contracts, lack of standards of conduct, etc.),</li> <li>– risk of data loss (e.g. possibility of sudden termination of operations by the provider);</li> <li>– the possibility of problems with the security of information processes carried out in the Internet space (e.g. cyberterrorism, hacker attacks, intelligence activities),</li> <li>– difficulties in quickly transferring data and changing the PMS system supplier,</li> </ul>
Economic	<ul style="list-style-type: none"> <li>– no need to purchase and develop IT infrastructure, which is the environment for the functioning of the PMS system,</li> <li>– no need to incur costs related to the launch and maintenance of specialized rooms (server room) necessary for the safe operation of PMS systems,</li> <li>– low cost of purchase and use of the PMS system (monthly subscription), which, together with the above-mentioned benefits, allows for converting CAPEX investment costs into OPEX maintenance costs spread over time,</li> <li>– lower demand for IT specialists (reducing the costs of acquiring, maintaining and developing administrators, including avoiding problems related to rotation, holidays, training, etc.),</li> <li>– relatively lower costs of modernization, upgrade and development of PMS systems (upgrade),</li> <li>– reduction of investment risk in the scope of the PMS system,</li> <li>– the possibility of avoiding the costs of modernization/replacement of existing computers,</li> </ul>	<ul style="list-style-type: none"> <li>– high cost of required broadband internet connections,</li> <li>– the need to incur additional expenditure on integrating data from different IT systems,</li> <li>– the possibility of incurring higher than expected costs due to the unsatisfactory level of services,</li> <li>– the risk of not taking into account the hidden costs of using PMS systems in the SaaS model (e.g. the cost of finding the right supplier, additional expenditure on implementation, monitoring and development of the PMS system, etc.),</li> </ul>

1	2	3
	<ul style="list-style-type: none"> <li>– better predictability of costs related to the use of the PMS system;</li> <li>– access to advanced PMS systems may affect the acquisition of valuable information and market knowledge, which in turn may improve the economic effects of VO.</li> </ul>	
<b>Technological</b>	<ul style="list-style-type: none"> <li>– the possibility for a VO to use the advanced in terms of content and technology PMS system, so far available mainly for large enterprises,</li> <li>– reliable VO access to the PMS system (availability at a level greater than 99%),</li> <li>– high level of security for PMS systems,</li> <li>– the possibility of professional and flexible technical support in the field of PMS,</li> <li>– constant access to the most recent versions of the PMS (including changes in functionality, noticed errors, etc.),</li> <li>– high scalability (in terms of the number of users) of the PMS system,</li> <li>– high performance of PMS systems,</li> <li>– by definition, the PMS system is adapted for use on mobile devices,</li> <li>– significant independence of the PMS system from the hardware and system software of OW partners and limiting the occurrence of conflicts regarding hardware and software configurations,</li> </ul>	<ul style="list-style-type: none"> <li>– the probability of a temporary decrease in the PMS system performance due to a temporary reduction in the Internet network capacity,</li> <li>– possible difficulties with data migration</li> <li>– the potential risk of creating local additional functionality that is necessary for the cooperation of OV partners and does not exist in the PMS system in the SaaS model,</li> <li>– the risk of unsatisfactory technical parameters of the PMS system (e.g. scalability, security, etc.),</li> </ul>
<b>Social and Environmental</b>	<ul style="list-style-type: none"> <li>– limiting business trips thanks to the possibility of free and mobile work of VO partners,</li> <li>– increased satisfaction of VO entities with the flexibility of work,</li> <li>– the possibility of deepening the relations and improving the cooperation of VO partners,</li> <li>– developing employees’ knowledge and stimulating further development of new IT technologies, which may result in the creation of new products,</li> <li>– the possibility of activating entities (e.g. employing the disabled, the elderly) or in a difficult economic situation as partners of VO,</li> <li>– protection of the environment by limiting energy consumption and reducing the emission of harmful substances (carbon dioxide released during energy production in conventional power plants),</li> <li>– reduction of the level of waste.</li> </ul>	<ul style="list-style-type: none"> <li>– the possibility of disturbing private relations (e.g. family) due to more frequent use of the PMS system (e.g. at the place of residence, during holidays, etc.),</li> <li>– the risk of losing the full anonymity of VO partners PMS system users in the SaaS model (collection of data by the provider regarding technical data of the device, software and even personal data, which may result in, for example, receiving spam),</li> <li>– the risk of mentality barriers of potential VO partners, which hinder the full effectiveness of the use of PMS systems.</li> </ul>

Source: own study.

the required functions of the PMS system that optimally support the activities of a VO. In addition, the diversity of VOs in terms of the goals pursued, the complexity of the project and the specificity of tasks performed for the client, intensifies the problematic nature of the detailed description of the PMS system supporting the activities of a virtual organization.

Responsibility for the selection and implementation of the PMS system supporting the functioning of the virtual organization rests with the VO integrator. Depending on the specifics of the acquired client order, PMS systems available in the SaaS model may not always be very advanced solutions. Initially, the integrator can use the limited number of functions available in PMS systems in the SaaS model. However, the further development of a VO, increasing the scope of work and complexity of the project, and the emergence of new information needs, may extend the scope of the PMS functions used to support VO activities.

In the author's opinion, PMS systems offered in the SaaS model are the optimal solution for supporting projects carried out in a virtual organization. The volatility and fluctuation of the virtual organization favour the use of PMS systems quickly available in the Internet space, which can be used without the need to purchase, paying a periodic subscription. The high requirements for PMS systems adopted by the integrator in a VO can be ensured by the SaaS model, because such solutions are characterized by high quality, efficiency and scalability, while maintaining an appropriate level of security of IT resources. Access and use of PMS systems in a VO for a specified period of time (usually limited by the client's order) seems to be the right solution for a virtual organization that is dissolved or reconfigured when the order is completed. The activities of a virtual organization are characterized by flexibility and dynamics, which requires the use of PMS systems with the same attributes.

The integrator's decision to select a given PMS system in the SaaS model to support VO activities is not easy (which is not facilitated by a large number of this group of systems with various functionalities) and should be preceded by a deep analysis. In the initial stage (i.e. after creating a virtual organization, appointing an integrator and cooperating entities), business goals and the time of their implementation are defined. In this phase, the needs of the cooperators are collected, the budget is established (including for the purchase and use of IT systems) and the principles of cooperation on the project under the VO are accepted.

In the next stage, the specifics of the SaaS model (benefits and threats) are identified and the market of PMS systems offered in the computing cloud is researched (currently the vast majority of vendors offer their IT solutions in the cloud). In particular, the analysis should cover the required functions and capabilities of PMS systems, which are necessary for the efficient and effective support of the adopted principles of cooperation of partners in the VO. The list of analysed PMS systems available in the form of SaaS, along with their characteristics and market share, should be obtained from reports and rankings published by independent research institutions or from studies of professional IT portals. For pre-selected PMS systems, it is also worth analysing the references obtained by their suppliers, case-study descriptions and additionally interviewing PMS customers in the SaaS model about their experiences related to this form of software use.

**Table 4.** Examples of PMS analysis and evaluation criteria in the SaaS model

Aspects	Description
Functionality	To consider whether the proposed SaaS services adequately support the current business model and to expect growth/reduction and change within the business plan
Security	To assess whether the SaaS provider demonstrates relevant security certification with standards such as ISO (International Organization for Standardization) 27001 or PCI DSS (Payment Card Industry Data Security Standard) given their specific scope
Availability	To consider whether the SaaS service delivery can demonstrate acceptable and measurable uptime consistent with the expected trading operations of the business
Network Performance	To assess whether the SaaS provider supports adequate network bandwidth and latency to deliver acceptable performance to all users
Resilience	To assess whether the SaaS provider has multiple locations from which it stores data backups and resilient hardware in order to recover from incidents including environmental hazards such as earthquakes and flooding
Organizational and financial stability/Due Diligence	<p>To assess whether the SaaS provider has proven success stories of SaaS service delivery.</p> <p>To assess the SaaS provider’s financial position. It can be done by assessing the size of paying consumer base. It takes longer for a SaaS provider to establish strong revenues as the pay per use model represents a slow but steadily building revenue stream.</p> <p>To assess whether multiple configurations on the software services are allowed due to SaaS multi tenancy feature</p>
Service Level Agreements (SLA)	To assess whether the SaaS provider gives a comprehensive SLA which include specific security elements. To assess the SaaS provider’s historical track record of achievement against this or similar SLAs for other customers
Service delivery management infrastructure	To assess whether the SaaS provider has sophisticated software in place to manage user provisioning, service level monitoring and reporting, incident tracking, versioning, server load balancing and infrastructure integrity in order to guarantee quality of service provided
Status visibility	To assess the SaaS provider’s ability to present service performance metrics to the SaaS consumer
Corporate governance	To ensure the SaaS provider is independently accredited for the location and data control if the SaaS consumer’s activities involve the processing of restricted data types for example, personal health information

Source: (Tan, Liu, & Sun, 2013).

In the next step, it is important to establish the criteria for the analysis and evaluation of both the PSM systems offered in the SaaS model and their suppliers. Individual PMS suppliers in the SaaS model can be assessed, among others, on the basis of: functional scope, brand, technology used, operating price, integration with other systems, flexibility in terms of operating fees, quality of technical support, speed of response to reported problem situations, the level of security applied, the market share of PMS system suppliers, terms of purchase, operation and resignation from the PMS system (SLA agreement provisions), number of recipients served, user

opinions, certificates (e.g. ISO), etc. Examples of evaluation criteria for IT systems offered in the SaaS model that can be applied to PSM systems and their vendors are shown in Table 4.

An important issue in the analysis of PMS systems in the SaaS model is the full recognition of the mechanisms and security rules used by the provider for the collected, processed and transmitted data. After thoroughly familiarizing oneself with the security procedures used by the supplier (e.g. protection mechanisms used in the Data-Center, storage of data belonging to different customers, encryption protocols used for transmitted data, supplier response procedures in extreme situations, the so-called disaster recovery, intrusion detection systems, insurance policies, anti-virus protection, etc.) and reviewing the provisions contained in the SLA, the VO integrator (in consultation with the partners) should decide whether the proposed level of overall security is acceptable.

**Table 5.** Benefits and threats related to the use of PMS systems in the SaaS model

<b>Factors</b>	<b>Attributes</b>
<b>Functionality</b>	Task Scheduling
	Resource Management
	Collaboration
	Time Tracking
	Estimating
	Risk Assessment
	Change Management
	Project Analysis/Reporting
	Document Management
	Communication Tools
	Process Development Method
	Portfolio Management
	Access Control
	Licence
Additional Features	
<b>Architecture</b>	Integration
	Scalability
	Reliability
	Security
<b>Usability</b>	User interface
	Customization
	User Support and Training
	Support for mobile devices
	Import/Export data
<b>Vendor Reputation</b>	Number of clients/users
	Brand value
	Level of Service offered
<b>Cost</b>	Annual subscription
	Total Cost of Ownership

Source: own elaboration based on (Godse & Mulik, 2009).

More precise criteria (factors) along with the attributes distinguished within them for the evaluation of PSM systems in the SaaS model are presented in Table 5. In order to assess PSM systems more precisely, their functionality can be further analyzed, e.g. in the area of Task Scheduling, Collaboration, etc.

In order to evaluate and select PMS systems in the SaaS model for a VO, appropriate evaluation criteria should be adopted. After establishing the main criteria for assessing PMS systems, appropriate weights (variable over time) are established, based on the preferences of the evaluator. A comprehensive assessment of the value of *j*-th supplier and *i*-th PMS software provided by them in the SaaS model (see Table 6), can be determined as the sum of the products of evaluations of individual criteria and the corresponding weights, i.e.

$$T_{ij} = \sum_{z=1}^n W_{zi}(K_{zi}) \cdot O_{zi},$$

where: *T* – the final value of the offer of *j*-th supplier for the delivered *i*-th PMS software in the SaaS model, made by the integrator or an authorized cooperating entity, *W<sub>zi</sub>(K<sub>zi</sub>)* – weight of *z*-th criterion (*z* = 1, ... *n*) in the scope of *i*-th PMS product for the evaluating entity, which is a function of the level of a given criterion, *O<sub>zi</sub>* – assessment of *z*-th factor for *i*-th PMS product, made by the evaluator (VO integrator).

**Table 6.** Analysis and evaluation of the PMS software vendor in the SaaS model for the VO

Criterion (K)	Weight of the factor (W)	Rate (O)	Value
K1	W1(K1)	[1-5]	W1(K1) O1
.	.	.	.
.	.	.	.
Kz	Wz(Kz)	[1-5]	Wz(Kz) Oz
Z – number of accepted evaluation criteria Z = 1...n	$\sum_{z=1}^n W_z(K_z) = 1, 0$	1 – lowest rate 5 – highest rate	$\sum_{z=1}^n W_z(K_z) \cdot O_z$

Source: elaborated on the basis of (Dziembek, 2010).

The prepared analysis and evaluation allows for the creation of a ranking of PMS systems best suited to the needs of a VO. More advanced decision-support methods (e.g. AHP, TOPSIS, PROMETHEE) can be used for this purpose.

The last phase of the analysis is testing the operation of the selected PMS and the positive confirmation of meeting all the necessary criteria established by the VO integrator. Conducting a thorough analysis of PMS systems is meant to facilitate the development of clear rules for selecting software, reduce the costs of wrong

decisions and avoid later disappointments of the cooperating partners at the time of launching the VO activity and using the PMS system.

## 5. Overview of the PMS offer in the SaaS model

According to Mordor Intelligence, the Project Management Software market is expected to register a CAGR of 10.67% during the forecast period (2020–2025). In turn, according to Grand View Research, the global project portfolio management market size was valued at USD 4.2 billion in 2019 and is expected to grow at a compound annual growth rate (CAGR) of 13.4% from 2020 to 2027. The growing adoption of cloud-based services for the remote monitoring of assignments is an essential factor that is expected to contribute significantly to market expansion. The Cappter report shows that most PMS systems are purchased in the cloud (60%), and 40% are on-premise solutions (O’Loughlin, 2019). These forecasts indicate a significant increase in the future use of PSM systems delivered in the SaaS model. Most likely, some of them will be used in supporting the activities of virtual organizations.

**Table 7.** Examples of PMS analysis and evaluation criteria in the SaaS model

<b>Selected examples of international PSM systems in the SaaS model</b>
24SevenOffice, Asana, Clarizen, LiquidPlanner, Mavelink, Microsoft Project Online, Monday.com, Zistemo, Wrike, Zoho Projects, Scoro, Basecamp, Trelo, ProofHub, Podio, Jira, Notion, Workfront, Samepage, MeisterTask, Paymo, Avaza, WorkOtter, GanttPRO Workzone, Nifty, Toggl Plan, Ora, GoodDay, Project.c.o Beesbusy, SpiraPlan, Easy Projects, Quir,e ClickU,p Lumeer, Slack, Teamwork, Mavenlink, ProWorkflow, FunctionFox, Azendoo, Forecast, Meisterplan, PM3, inMotion, ignite, Sci-forma, Genius Project, KeyedIn, Projects Rindle, awork, Proggio, craft, ProWorkflow, Smartsheet
<b>Selected examples of PSM systems in the SaaS model available in Polish</b>
IC Project, Jira, Nozbe, Wrike, Kanbantool, Nozbe, Planoid, PM Compas, Trelo, Taagly, Time Camp, Bitrix24, FlexiProject
<b>Selected examples of PSM systems available in a free version for a small team</b>
Hey Space, Time Camp, Asana, Flow, Basecamp, GoogleDocs, Trelo, Wrike, Bitrix, Collabtive, Feng Office Community Edition, dotProject, eGroupWare, FusionForge, LibrePlan, OpenProject, OnlyOffice, Project.net, ProjeQtOr, Redmine, Taiga, web2project

Source: own study based on websites related to PSM systems.

Market analysis allows for assuming that various types of project management support systems may be available, even as many as several hundred. A reduced list of examples of PMS systems offered in the SaaS model that can be used in domestic and international virtual organizations is presented in Table 7. The table also lists those systems that are offered free of charge or have free versions for several cooperating entities and few projects, which may be important for small virtual organizations or those striving for maximum cost reduction.



The growing popularity of the SaaS model and competition among suppliers on the IT market will probably contribute to the systematic expansion of the PMS system offer available in the SaaS model, improvement of technological aspects related to the use of PMS systems in the SaaS model and the development of CRM systems functionality in the SaaS model. The popularity and increase in the use of project management support systems in VO operations will be enhanced by further technological development, reducing the barriers and threats of the SaaS model, and an increase in the quantity and quality of free PMS software.

## 6. Conclusion

Changes in the environment have contributed to the evolution of enterprises towards dynamic virtual organizations. The creation and development of virtual organizations will depend on the use of appropriate information technologies. An interesting type of applications supporting the activities of virtual organizations are PMS systems, the functions of which facilitate the separation and settlement of work, teamwork, communication and many others.

Nowadays the SaaS model, which is a component of cloud computing, is becoming an increasingly popular way of purchasing and using various types of IT systems by enterprises, among them, a large group of PMS systems, which, due to their low cost of acquisition, ease of use and flexibility, can be successfully used in virtual organizations to support their activities. Entities grouped under the VO, deciding to use the PSM systems in the SaaS model, can obtain a number of strategic, organizational, economic, technological and social and environmental benefits. There are, however, certain risks associated with the use of PMS in cloud computing that the management and owners of SMEs should be fully aware of before making a the final decision on their exploitation.

The growing importance of cloud computing influences the increasing number of suppliers of PSM systems in the SaaS model. Further work of practitioners and scientists on the development of principles for the assessment and selection of PMS systems in the SaaS model and the popularization of the benefits of their use should encourage its wider application in enterprises from the SME sector. It is also necessary for suppliers to take further actions to eliminate threats and develop the functionality of the PMS systems made available in the SaaS model.

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