

MASTER

Improving the throughput time and answer quality of a technical support help desk with a knowledge management system

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Eindhoven, April 2013

Improving the Throughput time and Answer Quality of a Technical Support Help Desk with a Knowledge Management System

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in partial fulfilment of the requirements for the degree of

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Abstract

In this master thesis the technical support process of Tennant company, for technical questions from the EMEA region, is improved with the integration of a knowledge management system. The focus of this research is to decrease the throughput time of questions and increase the quality of the answer given by the technical support representative. First the baseline of the throughput time is determined of the initial process. The functions of a knowledge management system are analyzed to which extend they contribute to the improvement of the throughput time at the support help desk. With the guidelines of the Procurement-Oriented Requirements Engineering (PORE) model, a system is selected and the current technical support process is improved with an integration of a knowledge management system. The results, seven weeks after the implementation, indicate an increase of 37.3% on the average throughput time of cases. Over time there is a gradual decrease in throughput time visual. The quality of the answer is significantly improved with the new process and system.

Management Summary

This case research is performed at the technical support help desk of Tennant Company. The technical support help desk is improved with a case and knowledge management system to increase the throughput time and answer quality of technical questions directed to the help desk. The search for the correct answer to a question throughout many sources is time consuming and increases the throughput time of a question. Next to the fact that searching for the correct answer is time consuming, answers to questions are not stored or proactively shared and therefore knowledge is lost. Recurring questions are resolved with a new search to the correct answer, which is time consuming. There are also indications from customers that the quality of the answer provided by the support agent was not satisfying.

Both speed and quality are important factors for customer satisfaction. By improving the speed and the quality of answers to questions, the customer satisfaction increases and this could be beneficial for future sales. According to a simulation experiment of González, Giachetti and Ramirez (2005) a technical support process with a knowledge management system, outperforms a technical support process without a knowledge management system, in terms of improving the throughput time. The simulation study of a help desk supported with a knowledge management system, resulted in a greater than 50% decrease in resolution time and a 19% increase in throughput. Also the number of questions in a queue at the higher support levels decreased with more than 70%.

It is likely that the quality of the answer goes up by the availability of knowledge at the technical support help desk, because the agent can provide knowledge proactively and the answer is more complete (Grey & Durcikova, 2006). Reference cases can be used to extract knowledge and give the questioner a more "complete" answer.

Based on the results about knowledge management at a support helpdesk described throughout literature and the issues at the case company, the following research question is formulated:

To what extent does a knowledge management system incorporated into a technical support process improve the throughput time and the answer quality of customers' technical questions?

This research creates insight to what extent a knowledge management system contributes to a technical support process in terms of throughput time improvement. In contrast to other research, where Knowledge Management incorporated in a technical support process is simulated (González, Giachetti, & Ramirez, 2005), this research will provide real life data on the throughput time improvement. The generic solution is tested in the technical support process of a case company.

Measure

To determine a baseline for the performance of the technical support process, during a twelve weeks period, 518 questions were captured resulting in approximately 43 technical questions a week. The average throughput time of questions is 33.64 hours. The mean is inflated because of 86 extreme values. The outliers are checked whether they are errors in the data or not, but they are actually a result of the current process. Therefore it is interesting to check the median of the data which is 4.84 hours. When the mean is compared with the median, the results differ a lot. The queue at the technical support help desk is on average 9.3 questions.

Analyze

The issues in the technical support process of the case company causing the throughput time are coupled to specific functions of knowledge management systems. The issues concerning not having access to a knowledge source, not having up to date information, not adding and sharing researched information and using multiple personal knowledge bases, can be overcome with the functions like a database, a file repository or shared folders. In this way knowledge can be stored on a central place in the knowledge system. This central place is supported by the function of a knowledge portal with a direct line to technical support and knowledge. This overcomes the issue of not having a central contact point for technical support. With functions like keyword search and free-text searches, the issue of having no overarching search tool can be covered and knowledge can be found at the knowledge portal and data base.

A functions like instance tracking of a knowledge management system, solves the problems of not recording cases and not capturing answer to questions. With instance tracking the status of questions or cases can be monitored and it can create an overview in knowledge conversations. With the function of instance analysis, the issue of not having performance metrics of the process can be overcome. The function of a workflow system contributes to the issues of not having a prioritization method and prevents working around the technical support department, directly to the expert.

A knowledge management system function which can improve the quality of answers and learn from wrong answers, is a function to score and give feedback to a knowledge item. The function K-forms (knowledge forms) contributes in solving the issue of not having a standard question form. The issue of not providing information proactively, can be resolved by automatic notification messages send out to knowledge workers on subscribed knowledge items. The last important feature of a knowledge management system to overcome the issue of not using field knowledge, is the function of a discussion forum. In a discussion forum, knowledge workers can share their knowledge to discussions and questions. In this way knowledge is captured and available.

Improve

The knowledge management system is integrated into the technical support process and the performance is monitored of the technical support help desk over a period of seven weeks. In that period, 322 questions were directed to the technical support help desk, which comes down to an average of 46 questions a week. The average throughput time of technical questions was 46.19 hours, with a median of 21.63 hours. Figure 1 illustrates the evolvement of the throughput time over time for the seven weeks. Table 1 provides the development of the average and median over the respective weeks. On average, the throughput time of the new system is worse than the throughput time of the old system. The difference of the mean is significant with t(653) = -4.88 and p < 0.05

	Baseline	Improvement (hours)						
(hours)		7 - 13	8 - 13	9 - 13	10 - 13	11 - 13	12 - 13	13
Average	33,64	46,19	45,99	44,74	42,70	40,77	41,84	40,34
Change on Average		+37,3%	+36,7%	+33,0%	+26,9%	+21,2%	+24,4%	+19,9%
Median	4,84	21,63	21,68	20,77	19,84	18,64	20,79	23,91
Change on Median		+347%	+348%	+329%	+310%	+285%	+330%	+394%



Figure 1: Average Throughput time of technical questions per week

The quality of the answer is measured with a blind experiment, where customers had 10 question and answers of the old method and 10 of the new method. On average, the respondents rated the answer to the question for the new method (M = 4.179, SE = 0.090) higher than to answers to the questions of the old method (M = 3.571, SE 0.11). The results of the t-test indicated that the difference is significant t(43) = 4.23 and p < 0.05. The 95% confidence interval for the difference of the real mean is (0.318 ; 0.899).

Evaluation

The initial technical support process is improved with a new process and a knowledge management system. The results on the throughput time for the cases of the initial process and the new process were compared. From the result it is concluded that the throughput time of the new process was worse than that of the old process. These result were not expected, because the technical support representatives indicated that they had a better overview on running cases and the advantages of the system improved their way of working.

The results could be explained by the fact that the technical support representative had to learn the new system and the new process and this influenced the throughput time and the queue of questions in the first weeks. In week 11 the throughput time is at the lowest point, however in weeks 11 to 13 there were some staffing changes which influenced the throughput time. Next to that, the fulltime technical support representative had got some extra tasks besides the help desk, compared to the situation of the baseline measurement. The throughput time of the new process is also slightly inflated because of the issues during the implementation of the system.

The results on quality of the answer indicate a significant improvement. This might be explained by the fact that the support representative knows that the answer is captured for reuse at the help desk. So, on a quality point of view the new process and system improved the quality of the answers by the technical support help desk.

Because of the gradual decrease of the average throughput time and the increase of answer quality, it is recommended to continue working with the new process and system. It is recommended to do a third measurement on throughput time and quality in about six months, because at that stage there is more knowledge in the system and the support representative is used to the new process and system.

Preface

This master thesis is the concluding work of the study Operations Management & Logistics at the sub department Information Systems at the University of Technology in Eindhoven. The project was executed at Tennant Company NV in Uden, The Netherlands from October 2012 to the end of March 2013. During this period I had the opportunity to learn and improve the processes performed at a technical support help desk for a manufacturer of cleaning products. At the same time, I gained insight in knowledge management and knowledge management systems. The time I spend at Tennant Company working on my project was very educational and enjoyable for me.

I would like to thank my first university supervisor Remco Dijkman for his time and advice and keeping me in the right direction to make this project successful. I also would like to thank Rik Eshuis, my second university supervisor, for his advice during the project. I would like to thank my company supervisor Pier Dolmans for his time and support in improving the technical support process and for getting me acquainted in working at an international manufacturer of cleaning solutions. I would also like to thank the employees of the departments' customer support, current product development and service for their support during the project.

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Stefan Melis Eindhoven, April 2013

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1. Introduction

In this case research the throughput time and answer quality of questions at a technical support help desk are improved with a knowledge management system. A technical support representative needs to rely on his personal knowledge or knowledge in sources available to him. There are clear indications that a knowledge management system supporting the technical support representative in handling questions, improves the throughput time and the quality of the answer to the questioner (González, Giachetti, & Ramirez, 2005; Grey & Durcikova, 2006).

The case study is conducted at Tennant Company in Uden, which is a manufacture of cleaning machines. They have a technical support help desk for answering internal and external customers. The issues the help desk experiences are a high throughput time and answering recurring questions. From a quick research by the Current Product Engineering (CPE) engineers, it is discovered that it could take up to 12 handovers/steps until the answer has reached the customer. Customers indicate also that the quality of the answers from the technical support help desk are not satisfying, in terms of incomplete answers.

This document describes the approach and the outcome for improving the technical support help desk with a knowledge management system at the case company. The goal of this research is to contribute to the scientific research with real world experiment, and improve the performance at the help desk of the case company.

This chapter starts with a motivation for the research in section 1.1. Section 1.2 provides a background of a generic technical support help desk, about the process, the key performance indicators and the priority method. Section 1.3 provides background information about knowledge management systems incorporated into a technical support process gathered throughout literature. Section 1.4 discusses the research question, followed with the research approach in section 1.5. In section 1.6 the outline of the report is discussed.

1.1 Motivation

In an organization various kinds of knowledge is created, for example about products. This knowledge is scattered throughout the organization in documents, private knowledge bases or is captured in the mind of knowledge workers. If there is a question, the search for the correct answer is time consuming, because of the many sources that could provide an answer. This increases the throughput time of a question. Customers would like to have the answer as soon as possible and therefore a high throughput time of the business process decreases the customer satisfaction (Heckman & Guskey, 1998). To improve throughput time of the business process, the time to search for the answer needs to decrease. A way to do this is to incorporate knowledge management into the technical support process (Davenport, De Long, & Beers, 1998). The aim of knowledge management is improving an organizations' way of handling knowledge internal and external to the organization in order to improve the organizational performance (Maier, 2007).

Knowledge management is supported with a knowledge management system that offers functions to capture, organize, store and share knowledge. There are different applications for knowledge management systems. According to Weber, Aha & Becerra-Fernandez (2001) a knowledge management system should be incorporated into a business process, to prevent low system utilization by the users. A help desk process suits well to this presumption and there are knowledge

management systems which provide functions to answer customer questions in an alternative way. According to a simulation experiment of González, Giachetti and Ramirez (2005) a technical support process with a knowledge management system outperforms technical support process without a knowledge management system, in terms of improving the throughput time.

A knowledge management system might be a tool to improve the throughput time and the answer quality of technical questions. By improving the quality of an answer and the throughput time, the customer satisfaction increases. Next to that, by lowering the throughput time and the number of questions directed at the help desk, the number of resources needed to deal with the technical questions reduces. Another advantage is that knowledge is captured and will not get lost when an employee leaves the company.

1.2 Background of a Support Help Desk

Technical Support is a help desk setting where customers can ask their technical questions regarding the topic the help desk is specialized in. An example of such a help desk is an information technology helpdesk where people can ask computer related problems. The customer is served according specific support process.



Figure 2: Incident Management according to ITIL v3 [source: (IT Process Maps GbR, 2013)]

A reference process for a help desk is described in the Information Technology Infrastructure Library (ITIL) documentation (Best Management Practice, 2007), which is a set of best practices for service delivery, service support, etc. Although the best practices are focusing on ICT organizations, these best practices provide a reference for help desk processes for non-ICT-related organizations. According to ITIL, the service (help) desk process provides a single central point of contact for customers and contains the following key functions (Best Management Practice, 2007):

- Logging incidents or requests
- Categorizing and prioritizing of incidents
- First-line investigation and diagnosis
- Escalate incidents when it is appropriate to a second support line
- Close questions
- Keep customer informed of status of the service, incidents and requests.

The service desks operate generally as follows (Figure 2). Incidents, problems or questions are reported to the service desk by the customer and the incident is logged in a ticket. A ticket is a document with a full description of the incident (problem). The incident is categorized to identify the resource for handling the question and for trend analysis of certain incidents. The incident is then solved based on complexity. The relative simple incidents are handled by the first-line employee. If it is not possible to handle the incident by first-line employee, it is escalated to a technical support team with appropriate skills for handling the more complex incidents. After the incident is investigated, the service desk needs to ensure the user is satisfied with a clear answer. If the incident is solved, the incident is closed and stored in the solved incidents database. The database is used for a reference if a similar incident returns. (Pozgaj & Strahonja, 2008; Best Management Practice, 2007)

There are many structures to organize service desks. Service desks can be local such that they are physically close to the users, or centralized such that higher volume of calls can be handled with fewer staff. Another setting is a virtual service desk where staff is on many locations, but appears for the customers as one team. Service desks can also be arranged according "follow the sun" principle where the service desk in different time zones give 24-hour coverage by passing incidents to the location where staff is working (Best Management Practice, 2007). To fulfill the functions of a service desk there are five basic structures within a service help desk (Pozgaj & Strahonja, 2008), namely:

- Pool Structure
- Mobile Structure
- Layer Structure
- Specialized Structure
- Methodology structure.

In the pool structure every team member of the service desk has the same technology and amount of work. In the mobile structure, an employee receives the questions and assigns them to the right expert. In the layer structure the service desk employees are divided in groups, were the first level consists of employees with general and wide knowledge for solving the problem. If the first level employee is not able to solve the problem, it is transferred to the second level which consists of experts who are expected to be able to solve the problem. In the specialized structure the service desk is divided in several groups with their own expertise and are accountable for their own specific area. The methodology structure organizes the employees according the methods for providing

service to the customer and the employees are assigned according to their required skills in the team.

The Technical Support help desk offers a service to his customer by answering customers' questions. According to Heckman & Gukey (1998) the speed of the response is an important source which determines the satisfaction and dissatisfaction of the service. Performance dimensions which can be coupled to the execution of the Technical Support process, are time related performance indicators. To measure the performance of the Technical Support process there are metrics like, the throughput time of resolving a question; the number of questions resolved at first contact; and number of questions received at different support levels (González, Giachetti, & Ramirez, 2005). The throughput time of resolving a question, is the time it takes between the question is received at the help desk and the answer to the question is given and the question is closed. In that extent it can be seen how long it takes before a question is answered. The number of questions resolved at first contact by the support representative, is a quality related performance metric. The number of questions received at the helpdesk, is a quantitative number indicating the input of the Technical Support process and how many questions there are handled by the process.

There are different kind of questions that are addressed to a Technical Support help desk and these have specific characteristics dependent on the context setting. Therefore many help desks have priority categories where questions are assigned to (González, Giachetti, & Ramirez, 2005). The priority determines which agent handles the question. González et Al. (2005) proposes a priority scheme with four categories, namely critical, high, medium and low severity. The priorities are assigned to the questions regarding the criteria of Table 2. The criteria are mainly based on the impact the question or problem has on the customers' daily operations. With these priorities the throughput time for the questions with different priorities can be measured.

Priority	Criteria
Critical severity:	A system or a major system component is down or unavailable and the user
	cannot conduct critical business operations that will result in a significant
	loss of revenue, profit, or productivity.
High severity:	A problem that causes a partial or potential system or application outage.
Medium severity:	The problem does not severely impede the user's ability to conduct business
	and/or it can be circumvented.
Low severity:	A low impact problem that does not require immediately resolution, as it
	does not directly affect the user's productivity or system availability.

Table 2: Criteria for assigning priority to questions [source: (González, Giachetti, & Ramirez, 2005)]

1.3 Knowledge Management at a Support Help Desk

In total, four general issues can be tackled with a knowledge management system at a support help desk. The availability of knowledge is crucial for a customer/technical support help desk to provide the customers a satisfying response.

The first problem is not having knowledge accessible when it is needed. In this case the question is how to get knowledge at the right place, at the right time (Farenhorst, Lago, & van Vliet, 2007). This will mainly focus on transferring, storage and retrieval of knowledge from the system. Knowledge

must be available as close to the customer as possible, in a way the customer can solve the question by themselves. Performance indicators at a help desk for having knowledge available when it is needed, are the number of resolved questions at first contact, the throughput time of these questions resolved during first contact and the total number of questions directed to the help desk.

The second issue is the loss of resources and knowledge. This could be because of employees leaving the company or solving recurring issues without using knowledge that is discovered earlier. Help desk personnel indicate that they spent 60 – 70% of their time on solving repeating problems (González, Giachetti, & Ramirez, 2005). The challenge is to make knowledge available and meaningful to others (Alavi & Leidner, 2001). A performance metric at the help desk is the number of questions escalated to a higher support level and therefore this will also reduce the throughput time of the questions.

The third issue is a high throughput time for questions at a support help desk. The speed of the solution is one of the drivers for customer satisfaction about a help desk (Feinberg, Kim, Hokama, de Ruyter, & Keen, 2000), and therefore the throughput time should be as short as possible. The throughput time of questions is a key performance indicator for questions in the technical support process.

The fourth issue is bad quality of answers to questions at a helpdesk. Quality is another driver for customer satisfaction about a helpdesk (Feinberg, Kim, Hokama, de Ruyter, & Keen, 2000) and therefore the quality needs to go up. A performance indicator to measure the quality of the answer is the number of questions resolved at first contact and customer survey attached with the answer regarding the quality of the answer.

A knowledge management system has an intermediary function between the help desk agent and all data and knowledge available (González, Giachetti, & Ramirez, 2005). The knowledge management system supports the help desk agent in finding an answer to the question or directs you to an expert who is able to give the correct answer. Because the knowledge management system is able to record solved cases, this knowledge is available for all agents. For an agent it is possible to answer questions by matching the question with the solved cases and reuse the answers. In this way less questions need to be escalated to a higher support level and this should reduce the throughput time of questions. A knowledge management system provides a central place to store and share knowledge and therefore answers to questions can be found faster. A knowledge management system makes it capable to provide the customer a self-service portal, where customers can find their answers themselves. A simulation study by González et al (2005) to a knowledge management-centric help desk, where are help desk is supported with a knowledge management system resulted in a greater than 50% decrease in resolution time and a 19% increase in throughput. Also the number of questions in a queue at the higher support levels decreased with more than 70%. Although these are results of a simulation study and indicate a significant improvement for a support help desk by introducing a knowledge management system.

Knowledge published in the knowledge base is verified by the knowledge manager on its accuracy and completeness. Also solved cases are stored in the knowledge base which provides knowledge about how the question is answered earlier. Because agents have high quality knowledge available it is likely that the quality of the answer goes up, because the agent can provide knowledge proactively and more complete (Grey & Durcikova, 2006). For instance, if in a reference case there were multiple contact moments with the questioner to give him a "complete" answer, the answer of the new case can contain all this information in only one message to the customer and therefore the answer is of a higher quality.

Based on the literature above, Table 3 provides an indication to what extent the key performance indicators improve the help desk by introducing a knowledge management system.

 Table 3: Performance improvement at help desk with a knowledge management system [Source: [1] (González, Giachetti, & Ramirez, 2005); [2] (Grey & Durcikova, 2006)]

Performance indicator	Improvement
Number Received Questions (on different support levels) [1]	\checkmark
Throughput time of questions [1]	\checkmark
Number of resolved questions at first contact [1]	\uparrow
Throughput time of questions resolved at first contact [1]	\checkmark
Quality of Answer [2]	\uparrow

1.4 Research question

Based on the results about knowledge management at a support helpdesk described throughout literature, the following research question is formulated:

To what extent does a knowledge management system incorporated into a technical support process improve the throughput time and the answer quality of customers' technical questions?

This research creates insight to what extent a knowledge management system contributes to a technical support process in terms of throughput time improvement. In contrast to other research, where Knowledge Management incorporated in a technical support process is simulated (González, Giachetti, & Ramirez, 2005), this research will provide real life data on the throughput time improvement. The generic solution is tested in the technical support process of a case company.

The throughput time in the research question is defined as the time between receiving a question at the technical support help desk and sending the final answer back to the questioner. The answer quality is determined by providing the questioner an answer which is as complete as possible and therefore the questioner does not have to ask for further information. If both parameters are improved, this increases customer satisfaction (Heckman & Guskey, 1998). The customers in the process are both internal and external customers who have questions for technical support.

The scope of the research is based on the case company Tennant Company. Their technical support help desk is responsible for answering technical questions from (internal) customers inside the EMEA region and part of the escalation process of the customer support department.

1.5 Research Approach

The approach followed in this research to improve the technical support process is illustrated in Figure 3. Steps taken in this research are based on the research framework of Six Sigma (Brook, 2006), recognized by the phases the Define, Measure, Analyze, Improve and Control. Next to the Six Sigma framework, the research model of Davenport (1990) with five steps in process redesign is used. This model focuses on improving business processes with an IT solution and this can be recognized in the approach of Figure 3 by the tasks performed in the framework.

In the define stage an unstructured interview was conducted with the stakeholders of the process. An unstructured interview is used to discover the respondent's narrative about the topic and process. According to Blumberg et al. (2008) this interviewing technique is useful to gain insight into what the respondents consider relevant and how they interpret the situation. Throughout literature, background information is gathered to a generic help desk setting. With this information a research question and the research approach is defined.



Figure 3: Research output of the DMAIC phases

In the measure phase there are two major tasks performed, based on qualitative and quantitative research. The qualitative research is done to identify the current process, understand the human behavior regarding the current process and the bottlenecks within the current process. With the information of the define phase, an As-Is process flow is developed and improved with a semi-structured interview. The semi-structured interview is structured with an interview guide, which contains a list of rather more specific questions about the topic and process (Blumberg, Cooper, & Schindler, 2008). This semi-structured interview ensures that all necessary areas and questions are

covered in a similar way. The result is depicted in an Ishikawa diagram, pointing out the causes of the current performance. To determine the current performance, quantitative research is performed which is a systematic empirical investigation to the size of the current problem and set a baseline for the problem. The baseline is quantified by using statistics and mathematics. In this way, information is gathered about the throughput time and the number of questions for specified categories.

In the analyze phase a literature review is conducted, to discover the field of knowledge management systems as a possible IT solution for the problem. Specifically, there is searched for functions of knowledge management systems. The functions of knowledge management systems are matched to the issues in the case company, to what extent these functions can contribute to solve the issues.

In the improve phase, a knowledge management system is selected, based on the guidelines of the Procurement-Oriented Requirements Engineering (PORE) model (Maiden & Ncube, 1998). This model is designed to select off-the-shelf software packages. The actual system is chosen, based on a decision table of the different software packages. After the selection of the system, the system is implemented together with an adapted process. After these actions, the defined performance metrics of the new technical support method can be measured and compared to the baseline and the improvement in the quality of the answer is measured. As indicated in Figure 3, the control phase part of the Six Sigma model is out of the scope of the research, because it is meant for continuous improvement of the technical support process. This phase will be transferred to the process owners. After the results, there is a discussion to which extent the case represents data which is applicable for a generic support help desk.

1.6 Structure of the Report

The structure of this report is based on the phases and tasks as illustrated in Figure 3. Chapter 1 discusses the define phase which contains the research context, research question and research approach. In chapter 2, the case company is involved for baseline measurements on the throughput time, the number of questions and the different categories. The process and issues are investigated by using semi-structured interviews. Chapter 3 discusses the functions of a knowledge management system and to what extent the functions contribute to overcome the issues. In chapter 4 the technical support process is improved, by selecting and integrating a knowledge management system into the process. In the same chapter the results of the improvement are presented. Chapter 5 follows with a discussion to which extent the case is representative for a generic technical support help desk. The last chapter, chapter 6 discusses the conclusions and recommendations.

2. Case Company

The case study is conducted at Tennant Company. The Current Product Engineering (CPE) department in Uden, is responsible for answering technical questions, asked by (internal) customers in the Europe, Middle-East and Africa (EMEA) region. The technical support help desk experiences from customers that the throughput time of technical questions is too long and customers are not satisfied with the provided service. There is, however no overview of the technical support performance on throughput time, number of questions or quality of the answers. The CPE department wants to improve the technical support and increase the customer satisfaction.

In section 2.1 there is some background information provided about Tennant Company. In section 2.2 the current process for technical support is elaborated, based on interviews with the stakeholders. Section 2.3 presents the performance of the technical support process, based on research into the e-mail traffic of the help desk. In the final section 2.4, the issues in the process are discussed and depicted in an Ishikawa diagram.

2.1 Company Description

Tennant Company is founded in 1870 by George H. Tennant in northeast Minneapolis, where he made wooden products, primarily flooring, rain gutters and downspouts. With a few setbacks over time, around 1900 the company was one of the leading manufacturers of hardwood flooring in the Upper Midwest. Due to the deforestation, there was a need for Tennant to find new businesses. During the Great Depression, Tennant bought the rights of Ben Casper, who was a junior high school janitor. Ben Casper was tired of wet-mopping and hand-buffing the floors and invented a "machine" to "dry clean" the floors. In the 1930's Tennant entered a new industry with their first machine to clean floors. Tennant expanded his market and started an own factory in Uden in 1970. Nowadays, Tennant Company is represented in 95 countries. Tennant Company is an industry leader in America and third in Europe in floor cleaning solutions. Tennant Company is the worldwide leader in cleaning solutions without chemicals.

Tennant Company has its headquarters in Minneapolis and their manufacturing plants in Minneapolis; Holland, Michigan; Uden, Nederland; the United Kingdom; Limeira, Brazil; en Shanghai, China. There is also a Customer Support department for Europe located in Antwerp, Belgium. Worldwide Tennant Company has 2,800 employees and a revenue of \$ 754 Million [2011] (Tennant Company, 2012).

Tennant Company produces floor cleaning machines like scrubbers, sweepers, burnishers, vacuums, carpet extractors, industrial & city cleaning machines and floor coatings. An overview is illustrated in Figure 4. The focus of the company is to develop revolutionary technologies and equipment for sustainable cleaning solutions without chemicals.



Figure 4: Tennant Company product portfolio [source: Tennant]

Tennant Company sells his products only to other businesses. The key markets are, building service contractors, retail, manufacturing, warehousing, aviation healthcare, governments and more. Examples of companies are Walmart, Apple, Pepsi, Coca Cola and the US Open tennis games. The customers are located around the globe. Around 64% of the revenue is generated in America; 26% in Europe, Middle East and Africa; and 10% in Asia and the Pacific. Tennant Company sees upcoming markets in Russia and Asia. Tennant Company strives to serve the customer with an extensive range of products for every customer.

2.2 The current process at the case company

To discover the Technical Support process at Tennant Company, unstructured interviews are held with the stakeholders of the Technical Support process from the departments customer support, technical support, current product development, service and product training. Details of the interviewees are depicted in Table 4. These stakeholders take part in the Technical Support process in terms of providing and/or requesting knowledge. With the unstructured interview it is intended that the stakeholder can tell his story on how they experience the Technical Support process and how the process nowadays is executed.

Department	Role		
Customer Support	Team Supervisor		
Technical Support	Technical Support Representative		
Current Product Engineering	CPE Manager		
Sonvico	1. Service Supervisor The Netherlands		
Service	2. Service Manager EMEA		
Product Training	Trainer		

Table 4: Interviewees of unstructured interview

Based on the output of the unstructured interviews, an overview is created in Figure 5 of the interactions of the stakeholders with the technical support helpdesk. The uninterrupted arrow indicates the primary route for technical questions and the dashed arrow indicates the alternative routes of stakeholders. From Figure 5 it can be seen that different questioners have their own route and source to answer their question.



Figure 5: Interaction with stakeholders to answer questions

Customers and some dealers with a question call the Customer support, where support employees are specialized in languages and do not have technical knowledge about products. They use part- and machine- manuals to answer the question. If the question cannot be answered by the customer support representative, the question is passed to technical support. Most Tennant dealers often go directly to the trainer, who gives training to the dealers regarding new products and troubleshooting. Mostly, the question is answered by the trainer, but if not the question is passed through to a technical support representative or directly to a CPE engineer (expert). If the representative at technical support cannot answer the question, he finds an engineer or expert to answer the question. When the answer is found, the answer follows the same route back to the customer/dealer.

A service technician can have a question themselves or get a question from customers at the service site. When the technician does not know or cannot find the answer, he asks the service group leader. If he does not know the answer, he asks the service supervisor. The supervisor asks other service supervisors in other countries about the question or problem. In most cases, the answer is found and travels the same route back.

Department	Role	Number of people
Customer Support	Team supervisor	3
Technical Support	Technical Support Representative	4
Current Product Engineering	Product Engineer	1
	Service Supervisor The Netherlands	1
	Service Supervisor Germany	1
Service	Service Supervisor Great-Britain	1
	Service Supervisor Spain	1
	Service Lead Engineer The Netherlands	1
Product Training	Trainer	1

Table 5: Department and Role of Interviewee of Semi-structured interview

The output of the unstructured interviews, and later on the output of the semi-structured interview conducted with the stakeholders of the process indicated in Table 5, an As-Is process flow is created of the technical support help desk (Figure 6). This process needs to be improved for the case company. Appendix I illustrates the complete business process for technical support, overarching the different departments.



Figure 6: As-Is Technical Support Process at case company

The technical support help desk at Tennant Company is the central place in the organization for technical questions about products. The technical support help desk is part of the escalation process of customer support department. The customer support representative directs technical questions from customers to the technical support help desk, however the customer support representative remains responsible for direct contact with the customer and gives him the final answer. In the current process, not every technical question is directed to the technical support help desk. The questioners also ask their questions directly to the expert and keeping technical support out of the loop.

The vision of Tennant Company on an ideal technical support process is to provide customers answers to questions 24/7 by using a self-service website. If the answer is not there, the customer can contact the customer support department by phone, e-mail or chat. This first support level is

responsible for remaining contact with the customers, because they have the language and communication skills. They try to answer the customer questions by using the available knowledge. If the representative cannot find the answer, the question is translated in English and escalated to the second support level with deep technical knowledge and direct lines to experts (Technical Support). If the second level does not know the answer to the question, this level can submit the question to an expert. The answers from the expert goes back to the second level, where the answer is formulated in English and forwarded to the first support level answering the question of the customer. This process is controlled with performance indicators, measured on the different help desk levels.

2.3 **Performance of the current process at the case company**

With the As-Is process mapped, the performance of the process needs to be measured. Unfortunately, Tennant Company does not capture any information on the performance of the technical support. To get a reliable indication of the performance, the e-mail traffic of the technical support e-mail box is analyzed. A vast majority of the questions at technical support is received by e-mail. There is a collection of Technical Support e-mail from August 3rd until October 31st of 2012 available for research. This period contains twelve full weeks of data and this period is representative for the whole year. The first four weeks contain a holiday period for a large part of Europe, which is up to September. There is one remark in this measurement, namely the questions received by phone are not included in this measurement and they are also not captured. The consequence is that the real number of questions. Specifically, the sent items by Technical Support are analyzed, because these e-mails contain all data which is useful for the performance measurement. The information from the e-mails the following:

- The date and time the question has arrived at the technical support desk;
- The date and time the latest reply on the question has been sent by Technical Support;
- The question;
- The answer to the question.

With the date and time of both the arrival and the latest reply of the question, the throughput time of the questions can be determined by calculating the difference between the two dates and times. Because there is no structure in answering a question in an e-mail, it is not possible to monitor the first-response rate of questions and this information is lost. The technical support help desk basically handles questions based on the first-come, first-served priority rule. However the order of the inbox is arranged with the newest on top. Some cases get priority based on the importance of the issue or complexity of the issue, however there are no clear rules for that. With the information about the question and the answer, the question can be assigned to Tennant specific categories. By assigning the cases to a specific category, the throughput time can be assessed for specific categories. Naturally, some categories will take more time than others due to the availability of information. The categories of questions are divided into two levels, which is illustrated in Table 6. The indication of complexity of the answer is determined by the technical support experts.

Table 6: Categories of questions on two levels

Level 1	Level 2	Indication of
		Complexity of Answer
	General Question	Easy
General Question	Certificate / CE-request	Medium
	Documentation Problem	Medium
	Machine General	Medium
Machine Specification	Machine Option	High
Question	Machine Specification	Medium
	Machine Troubleshooting	High
	Part/Kit General	Medium
Part/Kit Question	Part/Kit Availability	Easy
	Part/Kit Identification	Medium
	Part/Kit Specification	Medium

During the twelve weeks period, 518 questions were captured, which results in approximately 43 technical questions a week. The data is analyzed with the statistical software Minitab 15. Figure 8 illustrates a histogram with the frequency of observed throughput times. From this figure it can be seen that the observed values are not normally distributed. Figure 9 illustrates a box plot of the observed values with a mean and a median. The average throughput time of questions is 33.64 hours. Although, the mean is inflated because of 86 extreme values. The outliers are checked whether it are errors in the data or not, but they are actually a result of the current process and therefore they cannot be removed. Therefore it is interesting to check the median of the data which is 4.84 hours. When the mean is compared with the median, the result differs a lot. This data is considered as the base-line to compare with the performance improvement of the process.

From the number of questions, also the queue at the technical support help desk can be determined, based on the received and sent questions. In Figure 7 the queue is illustrated. Based on the data, on average 9.3 questions are in queue at the technical support help desk.



Figure 7: Number of question in the queue at the technical support help desk



Figure 8: Histogram of the observed throughput time



Figure 9: Box plot of the throughput time of the observed values

For the different questions in the categories specified for Tennant Company, the throughput time and the median are measured. Table 7 illustrates the results for the different categories. The technical support representative assigns the question to a specific category. The average throughput times between the categories are compared to the median and they differ a lot. From Table 7 it can be seen that most questions are part/kit identification questions. The highest average throughput time is for general part/kit questions and this class also has the lowest median. The lowest average throughput time is for general machine questions. The highest median is for machine troubleshooting questions.

Category	Number of	Percentage	Average	Median of
	Questions	of all	Throughput time	Throughput
		questions	(hours)	time (hours)
General Question	30	6%	69.18	19.52
Certificate / CE-request	41	8%	27.92	3.50
Documentation Problem	17	3%	15.73	4.53
Machine General	13	3%	11.57	8.72
Machine Option	22	4%	34.07	16.11
Machine Specification	44	8%	27.07	3.27
Machine Troubleshooting	41	8%	47.98	19.71
Part/Kit General	25	5%	73.93	1.73
Part/Kit Availability	59	11%	27.97	3.87
Part/Kit Identification	174	34%	28.33	4.59
Part/Kit Specification	52	10%	25.08	3.29

Table 7: Number, Average and Median of throughput time of questions of specific category

2.4 Issues in the process

To discover the issues causing the current throughput time, a semi-structured interview is conducted with 14 stakeholders of the different departments. Table 5 illustrates the departments and the roles of the interviewees. This semi-structured interview ensures that all necessary areas and questions are covered in a similar way for all stakeholders by using an interview guide (Blumberg, Cooper, & Schindler, 2008). With the input of the As-Is process flow created from the unstructured interviews, an interview guide is developed for the semi-structured interview (Appendix II). The interview guide contains a list of specific questions about the current technical support in terms of performance and process. The goal of this semi-structured interview is to discover which problems the stakeholders are facing while taking part in the technical support process. The results of the interview are mapped in a cause-and-effect diagram in Figure 10. The categories are based on the standard 3M&P model for service processes (Kannan, 2012) and creates a structure for the issues which are causing the current throughput time.

The issues discovered because of the methods the help desk is using, can be related to the control of the process. The throughput time increases because there is nobody at the help desk to handle questions and the Technical Support representative is assigned to other tasks. Also technical questions are sent to the personal e-mail box of the technical support representative, which is only checked in the morning. There is no recording of cases and therefore there is no insight in which cases are handled and closed. The result is that there is no insight in the performance of the help desk in serving their customers. The questions are not handled according a certain priority method, except of the first-come-first-served rule, which is not strictly used. Apart from this there is no standard question form, which results in multiple contact moments and increases the throughput

time because of the missing information. There is also no knowledge available on which expert to contact for specific information.

For the category Materials (Information) the issues are related to the knowledge available for the technical support representative. The throughput time increases due to the quality of the available information, such as missing information in the ERP system, documentation which is not updated or is of bad quality. Documentation which is not available in color or in the right language for customers, complicates and influences the communication. Knowledge which is not available, because it needs to come from another time-zone, is not shared proactively by knowledge workers or is not captured, increases the throughput time. Because knowledge is not captured, returning questions are studied again which is a loss of resources and increases the throughput time. Questioners work around Technical Support due to bad experience with the help desk, like a long throughput time or bad quality of the answer. The result is a loss of knowledge about issues in field and possible solutions. Because of the absence of this knowledge, this influences the resolution time of questions about the same issue directed to the technical support help desk. Also when questions are forwarded to experts, the knowledge is not shared with Technical support and repeating questions need to follow the same escalating path, which increases the throughput time.



Figure 10: Cause-effect diagram of the throughput time for Technical Support

The issues within the Machine (Systems) perspective, also increase the throughput time. There is no information system at Technical Support that supports handling the questions. The only systems that are used, are an e-mail system and an Access Database for Technical Support. The result is that there is no overview in e-mail conversations which leads to confusion and wrong answers. The answers are captured in an Access Database, which is not capable of handling attachments, has an inconvenient structure and does not have a proper search tool. The database is also not available for others employees. On the other hand every employee/expert has its own knowledge base which is not

available for Technical Support. A lot of knowledge is scattered on network drives and there is no overarching search tool.

The last category is about People, which are the representatives of Technical Support Department. There is one position at the department which is rotated every six months, which means that there is a start up time to get familiar with playing issues in the field. After the six months the knowledge gathered at the help desk is lost. Other issues increasing the throughput time are the language skills and a lack of technical knowledge which influence the quality of the answer. Also uncertainty on giving the right answer results in double-checking the information, which results in an increase of the throughput time. An issue that (internal) customers experience is that the representative is not supportive in finding the answer. This means that the customer have to ask a lot of questions at the help desk, until they get a complete answer to their question. This also increases the throughput time of questions at the help desk.

3. Functions of a Knowledge Management System

This chapter presents a summary of a literature review conducted by Melis (2012) to functions of a knowledge management system. First, in section 3.1, the framework is discussed on how the functions of a knowledge management system are classified. Section 3.2 follows with relevant functions of a knowledge management system, as identified throughout literature. With the output of the literature review, functions that might be relevant in solving the issues of the case company, are discussed in section 3.3.

3.1 Literature Review: Framework

To classify the different functions of Knowledge Management Systems, Maier (2007) proposes a pragmatic classification on two levels. The classification is based on a framework of Zack (1999) and Hansen et al. (1999) and on additions of Maier (2007). This classification is used, because it is tested for a pragmatic classification of knowledge management system functions. In this way the functions are divided in groups with similar properties. The first level is about the classification based on integrative-, interactive- and bridging- functions.



Figure 11: Illustration of the framework

In Figure 11 the integrative-, interactive- and bridging- functions depict three branches. The integrative class contains functions, which are used for handling of explicit, codified knowledge

between participants in an asynchronous fashion. With these functions a knowledge worker interacts with the system and delivers input to the system directly. The interactive class contains functions that bring experts together to collaborate and share knowledge in an asynchronous or synchronous way. In this way, the integrated knowledge management system is a facilitator between knowledge workers in sharing knowledge. The framework with the interactive and integrative classes (Zack, 1999) is extended by Maier (2007) with a bridging class, which covers the gap between the integrative and interactive functions. This branch covers functions that cannot be assigned to one of the classes, but are part of both integrative and interactive functions. These functions link knowledge elements to knowledge networks and enrich the context for searching and presenting knowledge.

The system-centered classification is defined by Maier (2007) and is more abstract than a list of technical functions. The individual functions on a system level, are grouped in a more general set of functions on a higher aggregated level. Maier (2007) defined the following groups of functions:

- Knowledge search
- Knowledge presentation
- Knowledge publication, structuring and linking
- Knowledge acquisition
- Computer-based training
- Administration
- Tele-learning
- Knowledge communication and cooperation

In Figure 11 the system-centered classes are assigned to the classes of the first level. Not every system-centered class is assigned to the categories of the first level, because it does not match the definition. The integrative category covers the following system-centered classes:

Knowledge search

This category concerns all functions that are relevant for searching knowledge elements. For integrative functions, it only covers the pull function for searching knowledge.

Knowledge presentation

Knowledge presentation is close connected to knowledge searching. This category covers all functions about the (visual) presentation of relationships between knowledge elements before and after the search.

Knowledge publication, structuring and linking

This group of functions supports the organization of knowledge elements. These functions have a great influence on the quality of the search results.

Knowledge acquisition

Functions in this category increase the knowledge base of the system.

Computer-based training

These functions are intended to increase the knowledge of the knowledge worker. The functions create a learning environment between a computer system and a knowledge worker.

Administration

This category covers the functions regarding the reporting of statistics on knowledge elements.

The interactive category covers the following system-centered classes:

Tele-learning

These functions are intended to increase the knowledge of the knowledge worker with a learning environment between two knowledge workers in an interactive setting.

Knowledge communication and cooperation. The functions of this category facilitate in the communication and cooperation between knowledge workers. This communication can be both synchronous and asynchronous.

Administration

This category covers the functions regarding the reporting of statistics on knowledge workers.

The bridging category covers the following system-centered classes:

Knowledge search

This category concerns functions which are relevant for personalized searching throughout knowledge elements. For bridging functions, it contains both the pull and push function for searching knowledge. With a push function, knowledge finds people, instead there is searched for knowledge.

Knowledge presentation

Regards functions for visualizing relationships between knowledge elements, knowledge workers (experts) and the search results.

Knowledge publication, structuring and linking

These functions concern the organization and publication of knowledge based on the relationship between knowledge elements and knowledge workers.

Knowledge acquisition

With this function knowledge is gathered based on the relationship between the knowledge element and knowledge worker.

Administration

This category covers functions regarding the reporting of statistics on a similar group of knowledge workers, who share the same interests, preferences, privileges and/or function.

3.2 Literature Review: Functions of Knowledge Management System

The literature review by Melis (2012) discovered in total 26 articles, which contain 93 functions of a knowledge management system (Appendix III). These functions were assigned to the classes of the classification tree in Figure 11, based on the definition of the function and the characteristic of the class as described in section 3.1. In Figure 12 the number of functions per category is depicted. From this review it became clear that most functions are part of the integrative functions. These functions are extensions or supportive to the integrative functions.



Figure 12: Number of functions per category

Melis (2012) determined of the 93 functions, based on the frequency of a function discussed throughout the selected literature (Appendix III), a set of scientific important functions for a Knowledge Management System. This frequency is assessed against two decision rules. The rules are the following:

- 1. Functions with a frequency of seven or more, are incorporated in the framework.
- 2. If no functions are selected based on the first rule, a "clear winner" of that system-centered category is selected and incorporated in the framework. A "clear winner" has at least a frequency of two.

The frequency threshold of seven is based on a Pareto-analysis (Mulders, 2007) determined on all functions their frequencies. The Pareto-analysis is originally used for inventory management, to identify in what extent items contribute to the revenue. This principle is translated to identify functions which contribute the most in a knowledge management system, based on the frequency of a function discussed throughout literature. The focus is on the functions that contribute up to 50% of the total frequency. The result is a cut-off value of seven. In this way Melis (2012) created an overview of 27 important functions of a knowledge management system in Table 8, as defined from theory.

For knowledge search functions, text-driven search functions are frequently mentioned throughout literature. Keyword search, semantic / ontology-based search and queries are manually driven search techniques which are handled by a search engine. Most search functions use a hidden ontology structure, in which knowledge elements are organized to increase the retrieval speed and accuracy by understanding the contextual meaning. A bridging function, which improves searching in a knowledge management system, uses an user profiles and the preferences set into it. Also search functions based on social network analysis or community of practice are often discussed throughout literature.

Brandt et al. (2008) states that a knowledge management system should provide one single point of access. Through other literature this statement is well supported for integrative presentation functions. A portal or a single access point is recognized as a main feature for presenting knowledge. Other functions which are often described, are presenting best practices, lesson learned and yellow pages. The presentation of best practices gives a clear structured view of experiences with issues and is easily recognized as interesting information or knowledge by users. Yellow pages or an expert finder presents a structured view of knowledgeable resources. Bridging functions for the presentation of knowledge identified throughout literature are a knowledge map and a knowledge recommender. Both features support the shift, where knowledge finds the knowledge worker.

Integrative functions for publishing, structuring and linking of knowledge are (semantic) indexing, structuring by ontology's and categorization. These functions offer support for knowledge retrieval, by linking knowledge elements to concepts or categories. Another important function mentioned, is a function for storing knowledge in a database or a knowledge repository. In this way knowledge is available on a central point. Mining technology functions, such as text mining, data mining, pattern matching, process mining, are mentioned often, because of the technology to capture new knowledge from patterns discovered in existing knowledge. A version-management function makes it possible to track changes in knowledge and supports concurrent collaboration between knowledge workers. Workflow systems make it possible to execute tasks in a structured way and it is possible to

link knowledge items based on workflow rules. A bridging function that supports structuring, publishing and linking knowledge is a function for automatic notifications to a knowledge worker about changes in knowledge items.

	Integrative functions	Interactive functions	Bridging functions
	Knowledge search engine		User Profiles
Knowledge search	Keyword search		Social network (analysis) / Community of practice
	Semantic search		
	Knowledge Portal		Recommender
Knowledge	Best Practices / lesson learned		Knowledge map
resentation	Yellow pages / Expert finder		
	Ontology		Automatic notification
	Semantic indexing		
Knowladza	Categorization		
Knowledge	Taxonomies		
publication,	Database/repository		
structuring and linking	Data Mining		
	Version-Management		
	Workflow System		
Knowledge acquisition	Authoring / Annotation of documents / markup		Score / review / Criticize document / feedback / assessment mechanism
		E-mail	
Knowledge		Instant messaging	
communication and		(chat)	
cooperation		Discussion forums / board / news-groups	
Computer-based training	E-learning		
Tele-learning			
Administration	Authorization and Security		Personalization of user interfaces

Table 8: Knowledge Management System defined from literature

An important integrative function for knowledge acquisition as described throughout literature is authoring or annotating documents or knowledge. In this way knowledge is enriched with contextual knowledge which is important for their users. An important bridging function for knowledge acquisition is the assessment of knowledge with a score or other mechanism to provide feedback or to review a knowledge item.

For interactive cooperation and communication functions, throughout literature there is much focus on functions which provide instant messaging, e-mailing and discussion forums. With these functions knowledge workers can communicate and collaborate directly or in-directly to other knowledge workers.

An interactive function for computer-based training is e-learning. With this function knowledge workers can follow courses within the knowledge management system. Such a system exchanges knowledge between the system and the knowledge worker.

Important administrative functions identified throughout literature were security authorization and personalization of user interfaces, which are integrative and bridging functions respectively. The security authentication is meant to keep the knowledge safe from outsiders. Personalization of user interfaces makes it possible to integrate users' preferences to present search results and structure knowledge, based on their own preferences. This makes the system more accessible for users.

From this resulting framework, there are two interesting observations. The first observation is the central role of ontology. The function to structure knowledge is mentioned in most articles and provides input for other semantic functions, like semantic searching and indexing functions. There are promising results from research, where they using the semantic web for the representation, reuse and federation of knowledge (Zhang & Yin, 2008). The second observation is the socialization and personification of knowledge management systems. In the development of Knowledge. Management Systems more techniques are used to capture and offer personalized knowledge. Communication traffic between knowledge workers is tracked to offer knowledge, based on the social network (Reichling, Veith, & Wulf, 2007). The development of Knowledge Management Systems is focusing on representing knowledge as a set of concepts within a domain and offering knowledge based on personal needs. This is in line with the codification and personalization strategy as discussed by Hansen et al. (1999).

3.3 Useful Functions of Knowledge Management System at Case Company

There are some specific functions of a knowledge management system which can contribute to overcome some specific issues experienced in the process, as discussed in the Ishikawa diagram (Figure 10). These functions are extracted from the literature review of Melis (2012).

The issues concerning not having access to a knowledge source, not having up to date information, not adding and sharing researched information and using multiple personal knowledge bases, can be overcome with specific functions of a knowledge management system. These functions are a database, a file repository or shared folders and version-management. In this way knowledge can be stored on a central place in the knowledge system. This central place is supported by the function of a knowledge portal with a direct line to technical support and knowledge. This overcomes the issue of not having a central contact point for technical support. With functions like keyword search, freetext searches and (semantic indexing), the issue of having no overarching search tool can be covered and knowledge can be found at the knowledge portal and data base.

A function like instance tracking of a knowledge management system can facilitate to overcome the problems of not recording cases and not capturing answer to questions. With instance tracking the status of questions or cases can be monitored and it can create an overview in knowledge conversations. With the function of instance analysis, the issue of not having performance metrics of the process can be overcome. The function of a workflow system contributes to the issues of not having a prioritization method and prevents working around the technical support department, directly to the expert.

A function of knowledge management system which can improve the quality of answers and learn from wrong answers, is a function to score and give feedback to a knowledge item. The function K-forms (knowledge forms) contributes in solving the issue of not having a standard question form with pre-specified fields. The issue of not providing information proactively can be resolved by the function for automatic notification messages sent out to knowledge workers on subscribed knowledge items or a recommender functions which recommends knowledge items.

The last important feature of a knowledge management system to overcome the issue of not using field knowledge, is the function of a discussion forum or board. In a discussion forum, knowledge workers can share their knowledge to discussions and questions. In this way knowledge is captured and available.

The functions of a knowledge management system described in this section are used in the solution design for the case company and for the selection of an appropriate system.

4. Implementation

Based on the results of previous chapters, the case company wants to improve the technical support process with a knowledge management system. This chapter discusses the steps performed for implementation of the system at the case company. First, section 4.1 describes a conceptual solution which is used as input for the selection of a system. In section 4.2 discusses the selection of the knowledge management system, which is performed by using the steps of Figure 13. Section 4.3 discusses the new process which is followed at the technical support process supported with the knowledge management system. Section 4.4 discusses some issues regarding the implementation of the system, which influenced the results. Section 4.5 and 4.6 discuss the results on throughput time and quality, respectively. Section 4.7 provides a conclusion on the results.



Figure 13: Selection process for an off-the-shelf system

4.1 Conceptual solution

From the functions of a knowledge management system as discussed in chapter 3, a conceptual solution was designed.

Figure 14 illustrates a conceptual solution. The solution is based on the requirement of the company to search for a cloud-based system. In this solution, (internal) customers can contact technical support by using the self-service portal or by phone to a Technical Support representative. The customer and the support representative can search in the knowledge base for existing (resolved) cases or knowledge articles by using a full-text or keyword search. The access to knowledge is controlled by an access control function.


Figure 14: Illustration of the conceptual solution

Cases (questions) from customers are handled in the system by the support representative, such that progress is monitored and knowledge is captured. Such a case exists of a K-form which captures all relevant information to handle the case. With automatic notification messages the customer is proactively informed on the status of their question. The support representative can create knowledge articles in a Wiki to provide knowledge proactively in the self-service portal. Based on a score and rating function the customer can indicate how useful the article was in solving the problem. Based on the access level a customer of the help desk can submit the question at the discussion forum, where other users can contribute in answering the question of the customer.

This conceptual solution was presented to the stakeholders of technical support, which are Technical Support, Customer Support, Current Product Development, Product Training and Service. In a discussions session with the stakeholders, the conceptual solution was discussed and a list with functional requirements (Appendix IV) was created.

4.2 Selection of a Knowledge Management System

To improve the technical support process, a knowledge management system has been selected. There are a lot of different knowledge management systems available, but not all knowledge management systems are suitable for any process in an organization. There is a variety of IT tools that support different knowledge management processes in organizations (Alavi & Leidner, 2001). To prevent a low utilization of the knowledge management system, it should be incorporated into the business process (Weber, Aha, & Becerra-Fernandez, 2001). Therefore the selection of the system is very important, in a way it meets the objectives for the intended process. To get a structured approach for selecting the right system, the Procurement-Oriented Requirements Engineering (PORE) model (Maiden & Ncube, 1998) is used as a guideline. This model is a sound theoretical basis for selecting off-the-shelf products, based on the compliance with the product-requirements.

In the first step, product information was gathered by searching for knowledge management systems on the web, using the Google search engine, Gartner Research (Gartner, Inc, 2012) and websites comparing IT systems (CloudTools, 2012; Venturebeat, 2012; Capterra, 2012). The result is a set of 140 potential system vendors (appendix V). The second step was gathering customer requirements for the system, which are key features of the system. These requirements were gathered during a discussion session with the stakeholders of the process, were the conceptual solution of section 4.1 was presented. The list with requirements is available in appendix IV. In step three, the potential systems were assessed globally on some major features, based on the information of the vendors' websites. If it was not totally clear from the website, the vendor was contacted about the feature by e-mail. If there were slight doubts, it was indicated with a question mark. The four major features are the following:

- There is a ticketing or case management function
- The software is available as a service (SaaS)
- Knowledge base
- Has multiple discussion forums

While assessing the systems, the order above also determines whether there is searched further for the other major features, i.e. if there is no ticketing function found, there is not searched for a

knowledge base function. Finally, it was assessed if the system would match the other requirements of appendix V. This assessment resulted in a set of 47 potential systems marked in appendix IV along with their features. The Fourth step, was the development of a questionnaire and a guidance letter (appendix VI), which were e-mailed to the 47 vendors. The questionnaire was mainly focused on the features the system supports and some background information of the vendor. A deadline was set for the vendors to submit the questionnaire. This resulted in a response of 25 vendors of which 23 filled in the questionnaire. The results of the questionnaire are available in appendix VII. In step five, the responses were evaluated on their compliance with the requirements. Based on weight factors determined for the different features, the products were ranked according to their score and compliance with the requirements (See appendix VIII). In step six, the top five systems were evaluated with a trial version of the product. First the features of the questionnaire were confirmed with the trial of the product and there have been checked on the differences between the five systems. On this step, a first assessment was made whether the system complies with the needs of the case company. If this was not the case, the next system on the list was selected for a trial assessment, to keep five systems to pass the next stage. The systems passed are:

- Teamsupport Enterprise
- Zoho Support
- Freshdesk Garden plan
- CRMdesk
- Zendesk Plus

In step seven, additional information was gathered from the vendors about security and functional features, based on requirements set by the case company. Next in step eight, a hands-on session with the stakeholders was organized to evaluate the first three systems discussed above. In this session the stakeholders received an introduction to the three systems and a scenario to solve in the three systems (appendix IX). In this way, the users provided feedback on the different systems. The feedback was gathered from two internal customers (service engineers) and five agents (product trainer, expert, technical support representative and two customer support representatives). The feedback was registered on an evaluation form (appendix X) with questions about their experience in using the system. A summary of the results is depicted in appendix XI. The last step was the selection of a system with the management board, based on the following information about the system (appendix XII):

- Functional differences between systems
- Reporting Possibilities
- Support of provider (after sales support)
- Security of the system
- Reliability of the system
- User feedback
- Implementation time and cost
- Cost of the system

Based on this information the management board of the case company decided to go forward with the Garden edition of the Freshdesk system.

4.3 The New Process

The selected system supports help desk agents in solving questions or incidents by capturing resolved cases. These cases can be reused as reference knowledge for new cases or converted to a knowledge article published on the self-service portal. The setup of the system allows configuring a pre-specified process and the system guides the support agent to work in a pre-specified way.

The new technical support process of the case company is illustrated in Figure 15. As can be seen technical knowledge is provided proactively by serving the customer in a self-service portal, before customers contact the technical support help desk by phone or e-mail. When the customer contacts the support helpdesk, the technical support process starts. This process of Figure 15 is derived of the process of González et Al. (2005) were a knowledge management system is added to the problem resolution process. The system makes acquisition and reuse of knowledge possible and therefore the process is improved to benefit of these features. The simulation study of González et al. (2005) proved with this process a reduction in throughput time and therefore this process is appropriate for the case company.

The cases are recorded in a structured way and all relevant knowledge necessarily to solve the case is captured, like the category, priority and messages regarding the case. The cases are monitored based on the status assigned to the cases. The support agent searches the knowledge base for existing cases and if possible solves the new case. If the answer is not found, the case is assigned to the agent or expert who searches for the answer. The answer is communicated to a support representative who communicates the answer to the customer. The technical support representative has contact with the customer and is responsible for resolving the case of the customer. The support representatives are trained on how to address the customer correctly, know the language and are aware of the latest policy on what kind of knowledge is allowed to be shared with the customer. If an expert needs to be consulted, the answer of the expert is first directed to the support representative, which forwards the answer to the customer. In this way there is a central coordination of customers' questions and there is a clear insight in the progress of cases recorded by the support system. When the answer is provided to the customer and added to the case, the status of the case is set to closed, and the case is evaluated on criteria to provide knowledge proactively. Although, not indicated in the model of Figure 15, due to the clear structure, the support system is able to monitor the progress of a case and finally produce a report on the performance of the help desk.

At the end of the process there is a task to close the case and evaluate to what extent it is useful for the self-service portal for the system. The self-service portal is a knowledge base where knowledge about a specific subject is published and available to customers. By providing knowledge proactively, less cases need to be directed to the support help desk. When a case or subject is selected to share on the self-service portal, a knowledge article is created and submitted throughout the knowledge process of Figure 16. The technical support representative determines if there is extra information needed from another source or an expert. The representative can determine to write the article by themselves or ask the expert to write an article about the topic. When the article is ready, the article is submitted to a knowledge manager in the company, who is responsible for the quality and the content published on the self-service portal. The knowledge manager assesses the quality of the article on language and structure according a specific knowledge template (appendix XIII). The knowledge manager is someone in the company who is highly familiar with the products and also assess if the content in the article is complete. In the next step, the knowledge manager could

request the author to improve the article, or publish the article on the portal and register the article in a review database. This review database monitors which articles need to be reviewed, to keep the content up-to-date.



Figure 15: New technical support process



Figure 16: Knowledge Creation Process at Tennant Company

4.4 Implementation issues

The system was implemented on February 8th 2013 at the technical support department of Tennant Company and the technical support representative started to work with the process of Figure 15. At that stage the system was customized to Tennant Companies' preferences. All technical support email was forwarded to the system, and the system created tickets of the questions by e-mail. Unfortunately, there was an issue with automatically forwarding e-mail to the system by the exchange server and therefore all technical support e-mail was forwarded manually. The results presented in section 4.5, contain both the system results and the actual (corrected) results on the performance of the technical support process, due to this issue. Because the cases were not immediately forwarded to the system, the technical support representative could not handle the case. Therefore the performance of the help desk is based on the data from the system. For some existing cases the throughput time is inflated, because up-date messages were not immediately added to the existing case and influences the performance of the help desk. An issue which is caused by not automatically forwarding an e-mail, is that new tickets were created of messages that are manually forwarded, while the case is already as a ticket in the system. The technical support representative needs to merge the tickets manually and this is causing disruptions in the data from the system.

4.5 **Results on Throughput Time**

On April 5th of 2013, data about the performance was extracted from the system. Because of the issue of not automatically forwarding e-mail to the system, the data needs to be cleaned and corrected. The results presented in this section were measured over a period of seven weeks, from February 11th until March 31th of 2013. In total, 322 questions were directed to the technical support help desk, which were resolved by the support representative. The data is measured until April 5th, to give the questioners some slack to reopen the question if the question was not solved in their opinion and get data of a full week.

During the seven weeks there are on average 46 questions a week. Over this period the average throughput time of technical questions according to the records of the system was 46.19 hours, with a median of 21.63 hours. When the average and median are corrected with the time it arrived at the e-mail box before it was forwarded, the average throughput time is 48.97 hours and the median is 22.15 hours. Figure 17 and Figure 18 illustrate a histogram and a box plot of the throughput time, based on the data from the system. The shape of the histogram of Figure 17 indicates that the throughput time is not normally distributed. From Figure 18 it can be seen that there are eleven outliers detected. These outliers were checked whether they were errors in the data, but it turns out that these outliers were part of the process.



Figure 17: Histogram of the throughput time from data of the system



Figure 18: Box plot of the throughput time from data of the system

The throughput time at the technical support help desk is measured from the start of using the new system and process. Table 9 illustrates the development of the average and median of the throughput time for the different weeks for the system and corrected output. The table contains also the number of questions resolved for the respective week. In Figure 19 there is a graphic presentation of the throughput time. A first glance on the data indicates a trending increase of solved questions over time and a trending decrease of the throughput time. In week 11 the throughput time was at lowest for both the mean and median and after that the mean and median increases for the coming weeks. A remark should be made for the weeks 11 until 13. In week 11 and 12 the full-time technical support representative was not available and the tasks were executed by someone else with some experience with the job. However in this period, some cases in process by the technical support representative were set on hold and new cases had priority by the substitute of the help desk. In week 13 the full-time technical support representative who was handling only the urgent cases.

Week	Number of	Number of Average (ho		Media	n (hours)
number	questions	System	Corrected	System	Corrected
7	21	49,14	55,46	4,66	20,87
8	43	53,47	56,96	43,60	45,15
9	57	51,93	55,48	24,79	25,42
10	40	50,47	55,58	25,15	25,89
11	50	38,40	39,68	16,51	17,76
12	52	43,54	44,53	17,79	20,03
13	59	40,34	41,87	23,91	24,07

Table 9: Results of the performance of the technical support help desk



Figure 19: Average Throughput time of technical questions per week

Table 10 creates more insight in the averages and median aggregated with the specific weeks. In this way the influence of using a new process and system on the average and median is illustrated. From this table it can be seen that there is gradual decrease of the average and median over time.

Week	Number of	Averag	ge (hours)	Median (hours)		
number	questions	System	Corrected	System	Corrected	
7 - 13	322	46,19	48,97	21,63	22,15	
8 - 13	301	45,99	48,52	21,68	22,32	
9 - 13	258	44,74	47,11	20,77	21,36	
10 - 13	201	42,70	44,74	19,84	20,54	
11 - 13	161	40,77	42,05	18,64	19,64	
12 - 13	111	41,84	43,12	20,79	21,34	
13	59	40,34	41,87	23,91	24,07	

Table 10: Aggregated data for the averages and the median for week 7 till 11

From the receive and reply date and time, the queue for the questions directed to the technical support help desk is calculated. The average queue over the 7 weeks period is 12.8 questions. Figure 20 illustrates the number of questions in the queue at the technical support help desk from day to day, based on the data from the system. From this figure it can be seen that in the week of 18th February, the queue rises very fast to 25 question in the queue. This effect is caused by the migration of questions of the old system and start using a new system and process, which increased the number of questions in the queue for week 8. Eventually the backlog is reduced until week 11. Week 11 the queue rises slightly which might be the effect of the substitute for the technical support representative working with a new system. In week 13 the queue rises back to 20 questions, because the full-time technical support representative was not available for three days. On Friday of week 13 the backlog is reduced to five questions.



Figure 20: Number of question in the queue of the technical support help desk, based on the data from the system

Table 11 provides a comparison with the baseline and the improvement on the average and median of the throughput time. As can be seen from this data, the throughput times are worse, compared with the baseline. When comparing all data available from week 7 till 13, the average throughput time is increased with 37,3%. Gradually, over time the average throughput time gets better to, but it is still 19,9% higher than the baseline. When looking to the median of the throughput time, this is increased with 347%, which means that 50% of the questions are answered after 21,63 hours. Also in this data there is a gradual improvement visual, but it is still worse than the baseline.

	Baseline Improvement (hours)							
(hours	(hours)	7 - 13	8 - 13	9 - 13	10 - 13	11 - 13	12 - 13	13
Average	33,64	46,19	45,99	44,74	42,70	40,77	41,84	40,34
Change or	n Average	+37,3%	+36,7%	+33,0%	+26,9%	+21,2%	+24,4%	+19,9%
Median	4,84	21,63	21,68	20,77	19,84	18,64	20,79	23,91
Change or	n Median	+347%	+348%	+329%	+310%	+285%	+330%	+394%

Table 11: Average and Median compared with baseline and the improvement

The system also recorded the performance of questions, which belong to a category specified for Tennant Company. This categorization is now part of a task in the process described in section 4.3. The results on the performance for these categories are illustrated in Table 12 for both the system and the corrected data. From this data, the bottleneck seems to be the machine specification questions with an average of 84.20 hours. Most questions at the help desk are about the identification of parts or kits, which is 27% of the questions.

		Percentage	Average		Median	
	Number of	of all				
Category	questions	questions	System	Corrected	System	Corrected
General Question	20	6%	34,02	37,95	21,52	21,52
Certificate / CE-request	32	10%	35,80	36,43	17,35	17,43
Documentation Problem	17	5%	37,67	41,72	26,40	35,94
Machine General	13	4%	39,88	41,51	18,15	18,15
Machine Option	16	5%	39,26	41,21	19,81	19,83
Machine Specification	32	10%	84,20	85,54	67,36	67,37
Machine Troubleshooting	30	9%	76,40	76,80	47,08	47,61
Part/Kit General	14	4%	17,63	19,02	3,77	11,79
Part/Kit Availability	27	8%	36,81	39,28	18,82	19,20
Part/Kit Identification	88	27%	46,16	50,24	24,74	24,94
Part/Kit Specification	33	10%	29,46	34,79	17,17	19,95

Table 12: Number of questions, the average and median of throughput time for questions in specific category, based on system and corrected data

Table 13 provides data for the comparison of categories. From this table it can be seen that the distribution of questions on the different categories is roughly the same. The part/kit identification questions is still the largest category. From the data there is only an improvement visual for the general and the part/kit general questions. For all other categories the average is worse. When comparing the median of the throughput time, it appears to be worse for all categories of questions. Table 13: Comparison of baseline and improvement for questions of specific categories

	E	Baseline		Improvement		
Category	Percentage	Through	nput time	Percentage	Through	nput time
	of questions	Average	Median	of questions	Average	Median
General Question	6%	69.18	19.52	6%	34,02	21,52
Certificate / CE-request	8%	27.92	3.50	10%	35,80	17,35
Documentation Problem	3%	15.73	4.53	5%	37,67	26,40
Machine General	3%	11.57	8.72	4%	39,88	18,15
Machine Option	4%	34.07	16.11	5%	39,26	19,81
Machine Specification	8%	27.07	3.27	10%	84,20	67,36
Machine Troubleshooting	8%	47.98	19.71	9%	76,40	47,08
Part/Kit General	5%	73.93	1.73	4%	17,63	3,77
Part/Kit Availability	11%	27.97	3.87	8%	36,81	18,82
Part/Kit Identification	34%	28.33	4.59	27%	46,16	24,74
Part/Kit Specification	10%	25.08	3.29	10%	29,46	17,17

4.6 Results on Quality of the Answer

To measure the improvement of quality by using the new process and system, a blind experiment was conducted. A questionnaire was sent to 52 customers of the technical support help desk and in total 24 customers submitted the questionnaire (Appendix XIV). The questionnaire contained 20 cases with a question of a customer and the answer provided by the Technical Support representative (Appendix XV). The questions and answers were anonymized. The 20 cases contain ten questions and answers from questions captured in the old method and ten questions and

answers captured with the new method. These questions were randomly selected from the data set. The questions were presented to the respondent, without the knowledge from which method they come. The respondent was asked to assess the quality of the answer on a Likert 5 point scale, where 1 represents a bad quality of the answer and 5 represents a good quality of the answer.

The 24 respondents are divided into three groups. The results on the means and standard deviation for the old and new method are illustrated in Table 14. The results for the old and new method based on all groups are illustrated in Table 15. These results indicate that there is an improvement in quality of the answer by using the new system and process.

Group	N	Old Method		New	Method
		Mean	St. Deviation	Mean	St. Deviation
Customer Support	12	3.625	0.506	4.108	0.370
Service	7	3.585	0.581	4.37	0.411
Others	5	3.420	0.697	4.08	0.63

Table 14: Results for the different groups on the Quality of the Answer

Table 15: Results on the Quality of the Answer

Method	Ν	Mean	St. Deviation	SE mean
Old Method	24	3.571	0.550	0.11
New Method	24	4.179	0.441	0.090

4.7 Conclusion from the results

The results presented in section 4.5 about the throughput time, indicate that the results are worse with the new process and system, compared to the results of the baseline measurement. Both the average and median of the throughput time for the questions directed to the technical support help desk were increased. Over time there is a trending decrease visual for the throughput time. Over time, the number of questions directed to the help desk is slightly increased from 43 to 46 questions on average per week. The distribution of the questions from a specific category is the same for the baseline and improvement measurement. The part/kit identification questions is still the largest category. The results for the first week are influenced by the introduction of a new system and process and the results of week 11 to 13 are influenced by resource changes at the help desk.

From a quality viewpoint, the new system turns out to increase the quality of the answer provided to the customer. The blind experiment shows that the quality to the answers provided by using the new system are on average higher, compared to the quality of the answers provided with the old system. Therefore there is a positive improvement on quality by introducing the system.

5. Discussion

The results of chapter 4 indicate that the average and median of the throughput time was worse than using the old method. Over time there is a gradual decrease in throughput time, but it is still higher than the baseline. The results indicate that the quality of answer improved with the new system. Because every organization has its own process for providing technical support, there needs to be determined to which extent the technical support help desk at the case company is in line with that of a general help desk. Section 5.1 discusses the differences between the observed process and the reference processes of ITIL (Best Management Practice, 2007). Section 5.2 discusses the categorization and priority method of the case company and to which extent it is generic for other support help desks. In section 5.3 and 0 discusses the improvement in throughput time and quality of the answer, respectively. Section 5.5 provides a general conclusion to which extent the issues at the case company, the process and the results are generic for other support help desks.

5.1 The Process

The Technical Support help desk at the case company is classified as a centralized help desk with a layer structure, which means that there are multiple support levels. When the technical support process of Tennant Company is compared with the ITIL reference process (Best Management Practice, 2007) as discussed in section 1.2, the current process differs significantly as can be seen in Figure 21. In this figure the initial technical support process of Figure 6 is translated to the Incident Management reference process of ITIL v3. The black lines in Figure 21 indicate the initial process as discovered with the semi-structured interviews with the stakeholders of Table 5 and the grey lines and red cross icons indicate what is missing in the initial process compared to the reference process.

First, there is no incident management support at the initial technical support process. There are no tools supporting incident management and the monitoring of questions is performed by checking the messages in the Microsoft Outlook inbox manually. The second deviation from the reference process is not logging, categorizing and prioritizing incidents. In this way there is no overview of the number of questions at the helpdesk, the status of the questions and the type of questions asked. Third, because there is no overview created by logging questions, incidents cannot be monitored on their progress and if necessarily, escalated to the appropriate experts to commit to a specific service level. The fourth task missing, is closing the incident or question when it is handled or solved by the agent and evaluating on how the ticket is handled. Again, the status of a question is not known and there is no learning on how to solve the question in the future and appropriate store and tag the question for future reuse. Fifth task missing is proactive user information, where knowledge available at the help desk is shared to the customer proactively. Last, there is no incident management reporting. There is no insight in the number of questions of specific categories and how the technical support help desk is performing in terms of service delivery. Basically every e-mail represents a question, but the messages in the inbox might also be a follow-up of another message. The real number of questions is therefore lower than the number of messages in the inbox. Although there are differences with the reference process, the missing tasks are meant for controlling and monitoring the performance of the process. The basics of handling questions in a layered structure, which is a structure with multiple support levels, are followed in the initial process. On the knowledge part, the initial process is in line with the help desk without the support of a knowledge management system (González, Giachetti, & Ramirez, 2005), were knowledge is gathered from many different sources. To that extent the process represents a generic technical support process.



Figure 21: Initial Technical Support process matched to ITIL v3 incident management framework

The new process of Figure 15 supported with a knowledge management system improved the monitoring and controlling of cases on their performance and capturing knowledge. All tasks with a red symbol in Figure 21 are addressed in the new process, and therefore the new process is in line with the ITIL v3 incident management framework. The new process is also in line with the description of González et Al (2005) of a technical support help desk supported with a knowledge management system. The extra tasks in the process are necessarily for structured capturing of knowledge and these are highly facilitated by the knowledge management system, like the recording of cases. The system is implemented in the technical support process, without any knowledge available. The knowledge in the system evolves over time. The only knowledge the support representative had available, was the knowledge available by using the old support process. Therefore there is no improvement visual based on the availability of knowledge or reference cases.

5.2 Categories and Priority

In general, help desks use a severity priority rule to indicate in what order to handle the question at the support helpdesk. There are guidelines described which determine the priority of a question. The case company uses the first-come, first-served priority rule. However the new questions are always on top of the inbox, and therefore addressed quicker than messages which are placed lower in the

inbox. The support representative of the case company classifies the question to specific company related categories. Based on the category and question the support representative assigns a personal priority to the question, but does not flag the question to a specific priority and therefore is subjective. Actually the case company uses a priority rule, which is a mixture of priority methods. In the new process, the support representative could assign the questions to the same categories, but could also indicate the priority of the question. This priority is still unbounded to specific rules, but determines the due date of a case. To translate the case specific categories to that of a general help desk, the categories were assessed by the help desk agents according to their compliance with the definition of the severity priorities (Table 2). Table 16 illustrates the results on how the case specific categories match the severity priorities.

Category	Critical Severity	High Severity	Medium Severity	Low Severity
General Question				Х
Certificate / CE-request			Х	
Documentation Problem			Х	
Machine General			Х	
Machine Option		Х		
Machine Specification			Х	
Machine Troubleshooting	Х			
Part/Kit General		Х		
Part/Kit Availability		Х		
Part/Kit Identification		Х		
Part/Kit Specification			Х	

Table 16: Case specific categories matched to the severity priority categories

5.3 Improving the Throughput Time with a Knowledge Management System

The results of chapter 4.5 illustrate that the throughput time is worse than with the old system. To compare if this effect is significant, the results of the old and new method are compared with a t-test. Because the data is not normally distributed, the throughput time of the different methods is transformed with the natural logarithm.

Week number	t-value	Degrees of freedom	P-value
7 - 13	-4.88	653	0.000
8 - 13	-4.82	601	0.000
9 - 13	-3.79	479	0.000
10 - 13	-3.40	349	0.001
11 - 13	-3.00	262	0.003
12 - 13	-3.70	166	0.000
13	-3.17	74	0.002

Table 17: Results t-test for comparing the throughput time old system with the new system for aggregated weeks

For this data, the throughput times are statistically tested if they are different on the mean. On average, the throughput time of the new system is worse than the throughput time of the old system. The difference of the mean is significant with t(653) = -4.88 and p < 0.05. Also when comparing the results for the different aggregated weeks of the new system (Table 17), the results are all significant and indicate that the average throughput time of the new system is worse than with the old system.

5.4 Improving the Quality of the Answer with a Knowledge Management System

To check if the quality of the answer is improved the results are compared with statistic tests. The customers are divided into three groups, namely customer support, service and others. First with an ANOVA test the three groups were compared if they return different results on the mean. The test returned that there is no significant difference among the means between the three groups on a 0.05 significance level. Therefore the results could be tested for the whole group.

With this knowledge, the data from the questionnaire for the old method and the new method is compared by using a t-test. On average, the respondents rated the answer to the question for the new method (M = 4.179, SE = 0.090) higher than to answers to the questions of the old method (M = 3.571, SE 0.11). The results of the t-test indicated that the difference is significant t(43) = 4.23 and p < 0.05. The 95% confidence interval for the difference of the real mean is (0.318; 0.899). So, the new process improves the quality of the answer. This result might be explained by the fact that the answers to cases are captured in the system for reuse. Because the technical support representative knows that replies are captured for reuse, the representative replies with an answer of a higher quality.

5.5 General Conclusion

The problems and issues which are causing a high throughput time discussed in Figure 10 are similar to the general issues at a technical support help desk described in section 1.2. The issues come down to not having access to knowledge at the right time, losing resources and knowledge, a high throughput time for technical questions and a bad quality of answers provided by the help desk. Issues of not capturing knowledge and therefore is lost are resolved, as well as not sharing or have access to knowledge. The problems and issues at the case company are comparable to problems and issues at a generic technical support processes without a support of a knowledge management system. The process described during the research is in line with that of a help desk supported with a knowledge management system or not. Although the initial process misses the tasks for monitoring the cases, as described by the ITIL framework v3 (Best Management Practice, 2007). This might influence the observed results in improvement, because the cases in the new process are better monitored. The results on the throughput time indicate that the new process is significantly worse than the old process. Because the measurement is started directly at the start of using the new system and process, the results contain a learning period for using the new system and the throughput time is gradually decreasing over time. This effect would also be visual in other organizations when transferring to a new process and system. The results on the quality of the answer illustrate a significant improvement, when using a technical support process supported with a knowledge management system.

6. Conclusion

To satisfy customers of a technical support help desk, there needs to be focused on the speed and quality of the provided answer to the customer. The availability of knowledge at the technical support help desk is expected to increase the throughput time of cases and improve the quality of the answer from the support representative. According to a simulation experiment by González et Al. (2005) the integration of a knowledge management system on a support help desk, would decrease the throughput time of cases with more than 50%. Tennant Company wanted to improve their technical support process by improving the throughput time, lowering the number of questions directed to the help desk and increase the quality of the answer provided by the help desk. A knowledge management system integrated in the technical support process could be the answer to reach these goals. This is translated into the following research question:

To what extent does a knowledge management system incorporated into a technical support process improve the throughput time and the answer quality of customers' technical questions?

This chapter concludes with an answer to the research question and to which extend the goals are reached, followed with recommendations for further research. Section 6.1 discusses the details of the results produced by this research and the conclusion. In section 6.2 recommendations for further research and improvement of the technical support help desk are discussed.

6.1 Evaluation

The initial technical support process is improved with a new process and a knowledge management system. The results on the throughput time for the cases of the initial process and the new process were compared. From the result it is concluded that the throughput time of the new process was worse than that of the old process. The average throughput time increased with 37.3% and the median of the throughput time increased with 347%. From Figure 22 the throughput time decreases gradually. The average number of questions in the queue also increased from 9.3 cases to 12.8 cases. The average number of questions at the help desk increased from 43 to 46 questions. These results were not expected, because the technical support representatives indicated that they had a better overview on running cases and the advantages of the system improved their way of working.



Figure 22: Average throughput time per week for new process

The results could be explained by the fact that the technical support representative had to learn the new system and the new process and this influenced the throughput time and the queue of

questions in the first weeks. In week 11 the throughput time is at the lowest point, however in weeks 11 to 13 there were some staffing changes whish influenced the throughput time. The fulltime technical support representative was not available and substituted by someone else who had experience with the old process, but had to learn the new process and system. Next to that, the fulltime technical support representative had got some extra tasks besides the help desk, compared to the situation of the baseline measurement. This also effects the throughput time, because the help desk is not staffed as in the baseline measurement.

The distribution of the questions divided over the different company specific categories is the same. So this does not affect the change in throughput time, because some categories of questions are easier to solve than others. The Part/Kit identification class is in both the baseline and the improvement the biggest category with almost a third of all questions.

The throughput time of the new process is also slightly inflated because of the issues during the implementation of the system. These issues affect the throughput time negatively, because cases are not immediately updated with new messages from the customer and the technical support representative cannot react to this message until it is updated.

The throughput time at the help desk is influenced by staffing of the help desk, the complexity of questions and the implementation issues. The monitoring of questions at the help desk is improved, so cases could be measured more accurately. Because the knowledge base is developed over time with cases and articles, the limited amount of knowledge does not affect the throughput time. Eventually, the result indicates that the average throughput time at the technical support help desk with the new process is worse than with the old process.

The results on quality of the answer indicate a significant improvement. The survey among the customers of the help desk rated the answers to questions from the new method better on quality, than answers given with the old method. This might be explained by the fact that the support representative knows that the answer is captured for reuse at the help desk. So, on a quality point of view the new process and system improved the quality of the answers by the technical support help desk.

6.2 Recommendation

The results indicate that the throughput time with the new process and system is worse than with the old system. However, the results discussed in this report contain a learning period and there was limited knowledge available in the knowledge base, which both could influence the throughput time. The results look promising, because there is a gradual decrease visual in throughput time and the support representative also indicate they had more control and overview of running cases. A positive improvement is the quality of the answer given by the support representative. Therefore it is recommended to continue with the new process and system.

However to measure the real effect of the new process and system, the throughput time should be measured when the learning effect is disappeared and the employees are comfortable in working with it. Also the improvement in throughput time by capturing knowledge during the support process would be more visual if there are more cases and articles in the system. A large base of cases, should improve the throughput time of recurring cases. A large number of knowledge articles decreases the

number of questions asked at the technical support help desk. It takes time to build a knowledge base with a significant number of knowledge articles and cases. Therefore it is recommended to repeat the measurement over a year and monitor the change in throughput time.

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Appendices

Appendix I: Technical Support process into processes of stakeholders Appendix II: Semi-structured Interview guide Appendix III: Functions of Knowledge Management System Appendix IV: Requirements formulated from stakeholder meeting Appendix V: List of 140 system vendors Appendix VI: Guidance Letter and Questionnaire system selection Appendix VII: Results of questionnaire Appendix VIII: Results of questionnaire Appendix VIII: Weight factors and Score of Vendors Appendix IX: Scenario for the Hands-on session Appendix XI: Evaluation form for Hands-on Session Appendix XI: Evaluation results of systems Appendix XII: Comparison chart for selecting system Appendix XIII: Knowledge Article Template Appendix XIV: Response from Questionnaire Appendix XV: Introduction and Questions for measuring quality improvement

Appendix I: Technical Support process into processes of stakeholders

This is process flow illustrates the technical support process integrated into the support processes of different stakeholders.



Appendix II: Semi-structured Interview guide

These questions are used to structure the interview and assure the different perspective are discussed during the interview.

e	How do you define the process from your own position?
Defir	• Can you verify in what extent the following process is correct? (based on process flow)
	• Can you provide key figures about your own process flow? (Key figures like, how many
	Phone questions, mail questions)
	 Can you tell me what is the nature of the questions?
	 How many questions do you get? Can you indicate how these questions are divided
	over the categories?
	 How much time do you need to answer questions? (Search for information)
	 How much time does it take before a question is answered? (% in 24 hours)
	 Where do the questions come from? (%)
	• What do you think about the quality of the answer? What percentage is right the first
e	What do you do with questions that due to their nature belong to Technical Support?
asu	Are there alternative or specific processes for specific questions?
Ae	
	In your opinion, do you experience that the throughput time is too high?
	What is the cause of the high throughput time?
	Can you indicate the bottleneck in the process flow?
	Are there any other problems?
	 Are there problems in finding the correct answer?
	 Where do you get your information to answer the question?
	 In what extent can you answer the questions by yourself? (%)
	 How do you make your decision to whom you send your question?
	 Do you have insight in returning questions?
lyze	 How many times do you need extra information?
Ana	•
-	 How could the Technical Support process be improved? (Ideal Process)
	What kind of information do you miss?
	·
ve	
bro	
١٣	

Appendix III: Functions of Knowledge Management System

This appendix depicts a table with functions of a knowledge management system in the discussed framework with their frequency the function is mentioned throughout the selected literature. (Melis, 2012)

	System-centered category	Functions	Frequency
		Knowledge search engine / search agent	7
		Keyword search	7
		Keyword trimming	1
		Semantic Search / Ontology-base search	7
		Queries	4
		Hybrid Search	1
	Knowledge Search	Free-text search	2
		Rule-based reasoning	1
		Case-based reasoning/ Analytic Hierarchy Process (AHP)	3
		Browsing ontology categories / Semantic browsing	4
		Template / instance / process related Knowledge browser	1
		Keyword list / Glossaries	2
		Document driven search	1
		Thesaurus	2
		Navigation	5
	Knowledge Presentation	Graphical user interface	3
		Portal / Single point access	12
		Question and Answers / FAQ	2
_		Best practices / lesson learned	8
		Yellow pages / expert finder	8
		(Semantic) Indexing	10
		Untology's	15
		Categorization / classification	13
		Taxonomies	/
		Forksonomies	2
		Databases / Knowledge Tepository	1
		Tagging (add keywords)	5
		Neta Data	2
		Expiration date	1
		Locate original knowledge source	1
	Knowledge publication,	Text mining	6
ns	structuring and linking	Pattern Matching / recognition	3
io		Data Minina	8
ct		Rules miner	2
u		Fuzzy Logic	3
fı		Process Mining	1
Ve		Statistical data analysis	4
tiv		Maintenance Agent	2
ra		Version-management	8
8		Document management system / Database Management	6
It		system	
-		Workflow System	7

	Knowledge capture (while working on task)	2
	Process Knowledge tracking tool	2
	K-forms	1
	Linguistic Techniques	1
	Templates	4
	Links	5
Knowledge acquisition	Ontology reasoner and interpreter	5
	Social annotation	1
	Semantic annotation	4
	Media annotations	2
	Authoring / Annotation of document/ markup	8
	Importing tools/ info provider	2
	Web mining	1
Computer-based training	E-learning	4
	Authorization / security	8
Administration	Instance tracking	1
	Instance analysis	1

	System-centered category	Functions	Frequency
	Tele-learning	Web seminars	1
		E-mail	7
		Instant messaging (chat)	8
		Audio-based chat tools	2
S		Documenting E-room	2
u U		Shared folders/ file sharing	3
ti		Electronic meeting room	2
nct	Knowledge communication and	Mailing list / discussion list	3
5		Calendaring tools / time-scheduler	5
et		To-do list	2
. <u>></u>	cooperation	Electronic bulletin boards	4
Ct		Social Bookmarking	3
Ľa		Wiki	6
tel		Blogs (weblog)	4
Int		Discussion Forms / boards / news-group / electronic whiteboard	8
		Videoconferences	3
		Access Control / File locking	1
	Administration	Monitoring expert consulting	1
		Consulted webpage's	1

	System-centered category	Functions	Frequency
ctions		User profiles / Interaction History	12
	Knowledge Search	Collaborative Filtering	2
		Social Networks (analysis) / Community of Practice	9
		Process Oriented Map	1
		Automatic queries (from work content)	3
	Knowledge Presentation	Recommender	9
Ę		Knowledge map	13
f		Personal Dashboard	1
ള	Knowledge publication,	Expert system/ decision support tool	4
	structuring and linking	Automatic notification/ RSS	9
id		Web service interface	2
Ľ.		Score / Review /criticize document / Feedback /	7
	Knowledge acquisition	assessment mechanism	
		User Defined Knowledge acquisition	1
	Administration	Personalization of user interfaces	6

Appendix IV: Requirements formulated from stakeholder meeting

These are the requirements of the system, defined from the stakeholder meeting December 3^{rd} , 2012.

Requirements:

- Software as a Service (SaaS)
- Ticketing / Case Recording (Instance Tracking
- File Repository (knowledge base)
- Score/Rating function
- Full-Text searching
- Multiple Forums
- Workflow
- Frequently Asked Questions (FAQ)
- Notification Messages
- Wiki
- Self-service portal
- E-mail form (K-form)
- Access control
- Capable with Pictures and Videos
- Search function with filtering options
- Function to drill down to categories
- Subscription list of new knowledge items (Newly added knowledge items)
- Multiple access levels for knowledge
- Simple user interface

Optional:

- Mobile app for knowledge access
- Automatic translating functions

Appendix V: List of 140 system vendors

Here is a list of vendors of knowledge management systems, with a global assessment of the most important functions. In the list there is also indicated which systems are sent a questionnaire.

		Selected in step	icketing	aaS	nowledge ase	1 ultiple orums
NAME	WEBSITE	Three	Ъ	Ñ	хq	2 ш
Abacus Systems	http://www.abacus- systems.com					
Acquired Intelligence	http://aiinc.ca		×			
Adenin Technologies	http://www.adenin.com		~	×		
AdminiTrack	http://www.adminitrack.com		?	~	?	?
Advisor	http://www.advisor.nl/		?	×		
AJ Help! Desk	http://www.ajhelpdesk.com	Х	~	~	~	~
Akiva	http://www.akiva.com		×			
Allov Software	http://www.alloy-		~	×		
Altman Business	http://www.altmansolutions.co		>	~	?	?
Solutions	<u>m</u>			~		
Amdocs	http://www.amdocs.com		~	×		
Aptean	http://www.aptean.com		?	×		
Artologik	http://www.artologik.com		>	×		
Astute Solutions	http://www.astutesolutions.co		?	?	?	?
	http://www.auscomp.com.au		×			
Axonom Inc.	http://www.axonom.com	Х	>	~	~	?
Bitrix	http://www.bitrixsoft.com		>	×		
Bloxware Lessons	http://www.lessonslearnedser		×			
Learned Server	ver.com					
BlueCamroo	http://www.bluecamroo.com	Х	~	?	~	?
BMC software	http://www.bmc.com	Х	~	~	~	?
BrainKeeper	http://www.brainkeeper.com		×			
CAFM Explorer 2012	http://www.cafmexplorer.com		×			
Civerex	http://www.civerex.com		~	×		
Cloudsherpas	http://www.cloudsherpas.com		~	~	~	?
Column Technologies	http://www.columnit.com	Х	~	~	~	?
Comintelli	http://www.comintelli.com		×			

Comm100	http://www.comm100.com	Х	~	~	~	~
ComponentOne -						
ComponentOne	nttp://www.componentone.co		×			
Correlate	http://www.correlate.com		×			
Covide	http://www.covide.pl/		~	~	~	?
		v				
CRMdesk	http://www.crmdesk.com/	^	•	•	•	•
Cynapse	http://www.cynapse.com		×			
Cynergy help desk software	http://www.cynergysoftware.c om/	х	~	?	~	?
Dezide	http://www.dezide.com		?	×		
DoyleSoft	http://doylesoft.com/		×			
EasyCMDB	http://www.easycmdb.com		?	~	~	?
edocr	http://www.edocr.com/		×			
Efficy	http://www.efficy.nl	Х	~	>	~	?
eGain	http://www.egain.nl		~	~	~	?
Elsinore	http://www.elsitech.com		~	×		
FIT	http://www.fittrackingsolution s.com		~	~	~	?
five9	http://www.five9.com	Х	~	>	?	?
Freshdesk	http://freshdesk.com	Х	~	>	~	~
FuseDesk	www.fusedesk.com		~	*	×	×
Fuze Digital	http://www.fuzeds.com	Х	~	~	~	~
GLPI	http://www.glpi-project.org		×			
Gritware	http://www.gritware.com		~	×		
h2desk	http://www.h2desk.com/	Х	~	~	~	?
НарруFох	http://www.happyfox.com/	Х	~	~	~	?
Help Scout	https://www.helpscout.net		~	~	×	×
helpdeskpilot	http://www.helpdeskpilot.com		~	×		
HelpOcean	http://helpocean.com	Х	~	~	~	~
Helponclick	http://www.helponclick.com		×			
HelpSpot	http://www.helpspot.com	Х	~	~	~	~
HelpStar/Choreograf	http://www.helpstar.com		~	×		
Hesk	http://www.hesk.com		~	~	~	?
ii2p	http://www.ii2p.com		~	×		

iKode Helpdesk X	http://www.phphelpdesk.org/	Х	>	~	>	?
iKode Service Desk X	http://www.service- management-software.org/	х	~	~	~	?
Inflectra	http://www.inflectra.com	Х	>	>	>	>
InstantASP	http://www.instantasp.co.uk		>	>	×	×
isiHelp	http://www.isihelp.nl/	Х	>	>	>	?
IssueTrak	http://www.issuetrak.com	Х	>	~	>	?
ITRP	https://itrp.com		>	~	×	×
iuvoDesk Help Desk	http://www.iuvodesk.com	Х	~	~	~	?
Jitbit	http://www.jitbit.com		>	~	>	×
Kana	http://kana.com	Х	>	~	>	?
kayako	http://www.kayako.com/	Х	>	~	>	?
KBPublisher	http://www.kbpublisher.com		×			
KMI EHS	http://www.kminnovations.co m		×			
Knowledgeone	http://www.knowledgeonecor		?	×		
	p.com					
powered solutions	http://www.kpsol.com		×			
Liberum Help Desk	http://www.liberum.org		>	×		
logicnow	http://logicnow.com		>	~	>	?
Luit Infotech	http://www.luitinfotech.com		>	~	>	?
LuxorCRM	http://www.luxorcrm.com		>	>	×	×
Magnoware	http://magnoware.com/		~	×		
ManageEngine	http://www.manageengine.co		~	~	~	?
Microsoft Dynamics						
CRM	http://crm.dynamics.com	Х	>	>	>	?
Mojohelpdesk	http://www.mojohelpdesk.co m		~	~	?	?
	http://servicedesksoftware.mo					
Monitor 24-7 Inc.	nitor24-7.com		~	~	~	?
Moxiesoft software	http://moxiesoft.com	Х	~	~	~	~
MyServiceDesk.com	http://www.myservicedesk.co m/		v	~	~	?
Namura Software	http://www.numarasoftware.c					
(BMC)	om		~	×		
Nice	http://www.nice.com		~	?	?	?
NotoWare	http://trijsolutions.com		×			

Novo Solutions	http://www.novosolutions.com	х	~	~	~	?
Nutshell	http://www.nutshell.com		~	?	×	×
Omnistar	http://www.omnistarkbase.co	х	~	~	~	?
Onenkm	http://openkm.com	х	~	~	~	~
Oreala	http://openkin.com	x	?	~	?	?
Oracle	http://www.oracle.com	~	•	-	•	•
Oracle RightNow Technologies	ducts/applications/rightnow/o verview/index.html	х	~	~	?	?
OTRS	http://www.otrs.com		~	~	~	?
OVITAS	http://www.ovitas.com		?	×		
Pandell	http://www.pandell.com/		×			
Parature	http://www.parature.com	Х	~	~	~	?
PeerAware	http://www.peeraware.com		×			
Pega	http://www.pega.com	Х	~	~	?	?
perceptivesoftware	http://www.perceptivesoftwar e.com		×			
Perfectview	http://www.perfectviewcrm.nl		~	~	?	?
PhaseWare	http://www.phaseware.com		~	~	~	?
РНРКВ	http://www.knowledgebase- script.com		~	~	~	×
Qubics	http://www.qubics.nl		~	~	~	?
Rapid Incident Reporting	http://www.incidentreporting.		~	×		
ReadyDesk	http://www.readvdesk.com		~	~	~	?
ReadyDesk	http://www.revelationhelpdes	v				2
Revelation helpdesk	k.com	X	ľ	•	•	f
Rightanswers	http://rightanswers.com		?	~	~	?
Safeharbor Knowledge solutions	http://www.safeharbor.com	х	~	~	~	~
Salesforce	http://www.salesforce.com	Х	~	~	~	~
Salesforce Desk	http://desk.com	Х	~	~	~	?
Samanage	http://www.samanage.com		~	~	~	?
SAP	http://www.sap.com		×			
ScriptLogic	http://www.helpdesksoftware. com		~	×		
Secutor Solutions	http://www.secutorsolutions.c		×			
	http://www.sensesoftware.co		1			
Sense	<u>m</u>		~	~	~	?

Servigistics	http://www.servigistics.com		?	?	?	?
SkyDesktop	https://www.infostreet.com		×			
SMART Service Desk	http://www.smartservicedesk.c om		~	×		
SmarterTools Incorporated	http://www.smartertools.com	х	~	~	~	?
Solarwinds Web Help Desk	http://www.webhelpdesk.com		~	>	>	?
Spiceworks	http://www.spiceworks.com		~	×		
SugarCRM	http://www.sugarcrm.com	Х	~	>	>	?
SuperOffice	http://www.superoffice.nl	Х	~	>	?	?
SupportTracker.net	http://supporttracker.net/		~	×		
SysAid	http://www.sysaid.com	Х	~	>	>	?
Talisma	http://www.talisma.com		?	~	>	?
TeamHeadquarters	http://www.teamheadquarters .com		~	>	×	×
TeamSupport	http://www.teamsupport.com	Х	~	>	>	~
TOPdesk	http://www.topdesk.nl	Х	~	>	>	?
Traction Software	http://traction.tractionsoftwar e.com		×			
Trigent	http://www.trigent.com/		×			
twiki	http://www.twiki.net		×			
VersaSRS	http://www.versasrs.com		~	×		
VisionFlow	http://www.visionflow.com/	Х	~	>	>	~
Vivantio	http://www.vivantioservicedes k.com	х	~	>	>	?
WebGenerator	http://www.webgenerator.nl		×			
Widen	http://www.widen.com/		×			
WSN	http://www.wsn.net		×			
Xpert Technologies	http://www.xpert-asia.com/		×			
Zendesk	http://www.zendesk.com	Х	~	>	>	~
Zoho	http://www.zoho.com	Х	~	>	>	~

Appendix VI: Guidance Letter and Questionnaire system selection

The guidance letter for the questionnaire:

Dear Sir/Madam,

At this moment there is a project at Tennant Company (Uden) to improve the Customer/Technical Support to our customers and service engineers in Europe with an information/knowledge system. We are searching for an off-the-shelf cloud-based system which can provide support for our staff. From an initial assessment your solution is selected for a detailed investigation. We would like you to fill in our questionnaire about the functions of your software solution(s). The deadline for submitting the questionnaire is **December 18th**, **2012**. If you are not able to respond before that date, please send us a notification before December 18th, 2012. You can find the questionnaire attached to this e-mail.

The next step we will take, is to assess the questionnaire and software solution. We will contact you if your solution pass our criteria and are selected for our shortlist.

Kind Regards,

Stefan Melis | Intern at Current Product Development Uden, The Netherlands

www.tennantco.com

Tennant Company | Een schonere, veiligere, gezondere wereld maken.

TENNANT

The Questionnaire:

COMPANY INFORMATIO	ON		
Company Name			
Annual Turnover			
Number of Employees			
Number of products sold			
Customer References			
Product Name			
Functionalities			
(mark the criteria with YES if the s	system complies, or NO if the system doe	s not compl	y)
		YES	NO
Is the software provided as a S	Service (SaaS) or On-Demand?		
The software supports			
Ticketing?			
a Knowledge base?			
a discussion forum?			
a Self-service portal?			
multiple access levels?			
full-text searching?			
searching by drill-dowr			
a search function with			
Notification messages?			
Subscription to topics?			
the rating of knowledg	e items (feedback)?		
configurable workflows	s?		
functions for translatin	g languages?		
customizable e-mail fo	rms?		
Frequently Asked Ques	stions?		
automatically create/s	uggest Frequently Asked Questions?		
creating Wiki's?			
a file repository?			
a user-defined interfac	e?		
The software is capable for usi	ng multiple discussion forums?		
The software is capable for ser	nding notification messages from a		
discussion forum?			
Do you offer a trial version of t	the software?		
Do you have any Security Certi	ficates for		
the cloud-service?			
Remarks:			

Appendix VII: Results of questionnaire

	ane		estionair p	Jover	Employees	produ <i>c</i> ts sold	eferences	, e
	N Aueduo	Vebsite	illed in Qu	Imual Turr	lumber of	umber of	ustomer _R	roduct Na
1	Visionflow	/ >	NO		<	<	/0	
1	VISIONTIOW	http://www.visionniow.com/	NO			1000	GridPoint, Javelin, AT&T, Fujifilm, ATPA, Talon	
2	TeamSupport.com	http://www.teamsupport.com	Yes	U	15	1000+	Data American Airlines, Sun Trust Dank, ComEd, T	TeamSupport.com
3	Saveharbor Knowledge Solutions	http://www.safeharbor.com	Yes	0	<50	2	mobile +more	SmartSupport
							Capgemini, EA, Dolby, Ralph Lauren, Gexa	
4	Inflectra Corporation	http://www.inflectra.com	Yes	Need Agreement	12	6	Energy	KronoDesk
5	BlueCamoo, Inc.	http://www.bluecamroo.com	Yes			1		BlueCamroo
6	SmarterTools	http://www.smartertools.com	Yes			3		SmarterTrack
				We don't share this				
7	Zendesk	http://www.zendesk.com	Yes	information	300+	20000 Customers	See website	Zendesk
						100.000 SysAiders	New Wave Group: Rene Euverman	
8	SysAid Technologies Ltd.	http://www.sysaid.com	Yes		100+	arround the world	+31523238254 (rene.euverman@nwg.se)	SysAid Enterprise
9	ZoHo Corporation	http://www.zoho.com	Yes			22	Ikea, HP, Fortified on Demand & PESA CAT	Zoho Support
							Tennant, Drager Medical, Terberg	
10	Superoffice	http://www.superoffice.nl	Yes		220	11000	Systeemintegratie	Superoffice Customer Service
11	Desk.com	http://desk.com	No					
12	@work management associates	http://www.atworkmgt.nl	Yes	4.2 million (2012)	30	350 on-premise and 90 online	DAF, Struktion, TMF group, Van Iperen, TNT Fashion group	Microsoft Dynamics CRM
13	Freshdesk inc	http://freshdesk.com	Yes	we are 2 years old company with revenu <5 million and we are funded by accel partners and Tiger Global	60	2807 customers		Freshdesk
14	UserScape inc	http://www.helpspot.com	Yes		5	1	Red Cross, Catalyst, Slicehost,	HelpSpot
15		http://open/up.com	Ves	1 2 MI	15 Direct, 35	hundrode	last one are: Grupor; Seeo; Institute Genoma Singapur; Possehl electronics; Green Bear Corporation Poland; Danish Shipowners Accident Jeurapeo Accocistion: Eurobandor	DecertAd DMC
10	DE de set CD. 7	http://openkin.com	Tes Ver	1.2 WIL	External	nunureus	Correfour Louis Welters Kluwer Microsoft	
10	naugust 37. 20. 0.		Ves		5	4 (CRMdesk.com, teamdesk.net, dbflex.net,	LIDE Aleetel	
1/		http://www.crmdesk.com/	165			puguack.net)	ors, Aicatel,	
18	Vivantio Ltd	nttp://www.vivantioservicedesk.com	Yes	2m	21	2	iviark and spencer, Iosniba, Yodei	vivantio Service desk, Vivantio ITSM
19	Cynergy Software	http://www.cynergysoftware.com/	Yes	0	11	1	Yes	Cynergy Software
20	Kayako Help Desk Private Limited	http://www.kayako.com/	Yes		100+			(Fusion)
21	Yellowfish Software	http://www.revelationhelpdesk.com	Yes					Revelation Helpdesk
22	SugarCRM inc.	http://www.sugarcrm.com	Yes		+/- 400	>1,000,000 users, more than 10 million downloads	Bernecker + Rainer, Roxtec International AB, General Motors Colombia, Tollpost Glove AS Zurich Insurance, Vanderlande industries, Dutch Police, Etc	Enterprise Edition
23	Fuze Digital Solutions, LLC	http://www.fuze.com/	Yes	see remarks	10	see remarks	see remarks	Fuze Suite
24	Moxie Software Limited	http://moxiesoft.com	Yes		250+	600 customers	Lebera, Epson, Sharp, P&O Ferries, O2	Moxie's Knowledge Spaces
25	TOPdesk	http://www.topdesk.nl	Yes	22 mln Euro	420	4500+	3000+	TOPdesk
					.20	1	l	· - · · ·

QI	Company Name	Is the software provided	emand? "Ovided as a Service (Saas) or	Titcleer		racional discussion of the second sec	a Self-service port-12	ant in the access levels	full-text searching	and by drill-down categories	unction with filtering optiones	Notification messace	Subscription to topics	a knowledge items (feedback)	function	unns for translating language 5	Customizable e-mail formes	automatically reading Asked Questions		Creating Wike	a ser	The software is caned user-defined interface	The software is control of the software is contr	Do you offer a trial you for sending notification	ersion of the software?	/
1	Visionflow																									
2	TeamSupport.com	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES		
3	Saveharbor Knowledge Solutions	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES		
4	Inflectra Corporation	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	NO	NO	YES	NO	NO	YES	YES	YES	YES	YES		
5	BlueCamoo, Inc.	YES	YES	NO	NO	YES	YES	YES	YES	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO	YES	YES	NO	NO	YES		
6	SmarterTools	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	NO	YES	NO	NO	NO	NO	NO	NO	YES		
7	Zendesk	YES	YES	YES	YES	YES	YES	Yes	NO	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES		
8	SysAid Technologies Ltd.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	NO	YES	YES	NO	NO	YES	YES		
9	ZoHo Corporation	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	-	-	YES	-	YES	YES	-	YES	-	YES	YES	YES	YES		
10	Superoffice	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO	NO	YES		
11	Desk.com																									
12	@work management associates	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	NO	YES	YES	YES	YES	NO	YES		
13	Freshdesk inc	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES		
14	UserScape inc	NO	YES	YES	YES	NO	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES	NO	NO	NO	NO	YES	YES	NO	YES		
15	OKM GESTION DOCUMENTAL	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES		
16	Radgost SP. Z o. o.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	-	YES	YES	YES	NO	YES	YES	YES	YES	YES		
17	ForeSoft Corporation	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES		
18	Vivantio Ltd	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	YES		
19	Cynergy Software	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES		
20	Kayako Help Desk Private Limited	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	-	YES	YES	-	-	YES		
21	Yellowfish Software	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO	YES	YES	NO	YES	NO	NO	NO	YES	YES	NO	NO	YES		
22	SugarCRM inc.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES		
23	Fuze Digital Solutions, LLC	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES		
24	Moxie Software Limited	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES		
25	TOPdesk	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	NO	NO	YES		
9	Ompany Name	Do you have any Security Certificates for the cloud. Service?	lemarks																							
---------------------------	---	--	--																							
~	/0	1	4																							
1	Visionflow	Yos, wo are ottas socure which can be	Thanks for your RFI, but unfortunatley we don't have support for all your requirements yet. Specifically the feature "functions for translating languages?", does not exist in the system. However, since "Google Translate" works so well, this will be integrated into our software in the near future to cover this requirement. I wish you best of luck in finding a suitable software.																							
		res, we are mups secure which can be																								
2	TeamSupport.com	viewed in the browser	http://www.youtube.com/watch?v=oaopsc61QUo																							
	Saveharbor Knowledge																									
3	Solutions	YES																								
4	Inflectra Corporation	Yes, we have a SAS70 Type II certificate for our hosted/cloud service																								
<u> </u>		·····	There is a 21 day free trial BlueCampoois primarily a CBM and Brojert Management suite, but with sourced other features. There succeed us and																							
5	BlueCamoo, Inc.	YES	knowledge base or forum functionality built-in, however there are plans for a knowledge base. Also, the user interface is fully configurable by modifying the CSS. A few questions: - By a discussion forum, did you mean directly interfacing with a forum you're hosting? - Selfservice portal: People can be invited to become external Users and raise tickets ans view project details. They can also read the progress from any submitted ticket You're interested in creating and managing an internal wiki?																							
6	SmarterTools	We support SSI	At this time the end users would not be able to alter or change the nortal interface in any way. Only an Admin of the system could make changes																							
_		HTTP://www.zendesk.com/support/reg																								
/	Zendesk	al-info#privacyPolicy																								
			SysAid Technologies serves a constantly growing customer base of over 100.000 organizations in more that 140 countries worldwide. With scalable																							
8	SysAid Technologies Ltd.	Please see attached PDF for Our cloud DRP	solutions for organizations of all sizes, SysAid is deployed at companies in multiple industrie, from smaal and medium-sized businesses to fortune 500 companies alike.																							
8	SysAid Technologies Ltd. ZoHo Corporation	Please see attached PDF for Our cloud DRP YES, HTTPS://WWW.ZOHO.COM/SECURITY. HTML	solutions for organizations of all sizes, SysAid is deployed at companies in multiple industrie, from smaal and medium-sized businesses to fortune 500 companies alike.																							
9	SysAid Technologies Ltd. ZoHo Corporation	Please see attached PDF for Our cloud DRP YES, HTTPS://WWW.ZOHO.COM/SECURITY. HTML	2IE EMAIL: Tennant is implementing SuperOffice Sales & Marketing Online. Our SuperOffice Customer Service module is not yet available in our online portfolio. This solution needs to be implemented on-premise or partner hosted. The power of our solution is that both the Sales & marketing solution and Service solution share the same customer database. Sales can get insights in service statuses and service can get insights in sales statuses. To be able to use both solutions on one database your solution needs to be moved on-premise. We deliver secure solutions to give access to all users throughout Europe. For On-Premise deployments we also provide monthly payment plans																							
8 9 10	SysAid Technologies Ltd. ZoHo Corporation Superoffice	Please see attached PDF for Our cloud DRP YES, HTTPS://WWW.ZOHO.COM/SECURITY. HTML	2IE EMAIL: Tennant is implementing SuperOffice Sales & Marketing Online. Our SuperOffice Customer Service module is not yet available in our online portfolio. This solution needs to be implemented on-premise or partner hosted. The power of our solution is that both the Sales & marketing solution and Service solution share the same customer database. Sales can get insights in service statuses and service can get insights in sales statuses. To be able to use both solutions on one database your solution needs to be moved on-premise. We deliver secure solutions to give access to all users throughout Europe. For On-Premise deployments we also provide monthly payment plans comparable to cloud pricing.																							
8 9 10	SysAid Technologies Ltd. ZoHo Corporation Superoffice	Please see attached PDF for Our cloud DRP YES, HTTPS://WWW.ZOHO.COM/SECURITY. HTML	ZIE EMAIL: Tennant is implementing SuperOffice Sales & Marketing Online. Our SuperOffice Customer Service module is not yet available in our online portfolio. This solution needs to be implemented on-premise or partner hosted. The power of our solution is that both the Sales & marketing solution and Service solution share the same customer database. Sales can get insights in service statuses and service can get insights in sales statuses. To be able to use both solutions on one database your solution needs to be moved on-premise. We deliver secure solutions to give access to all users throughout Europe. For On-Premise deployments we also provide monthly payment plans comparable to cloud pricing.																							
8 9 10 11	SysAid Technologies Ltd. ZoHo Corporation Superoffice Desk.com	Please see attached PDF for Our cloud DRP YES, HTTPS://WWW.ZOHO.COM/SECURITY. HTML	Solutions for organizations of all sizes, SysAid is deployed at companies in multiple industrie, from smaal and medium-sized businesses to fortune SOO companies alike. ZIE EMAIL: Tennant is implementing SuperOffice Sales & Marketing Online. Our SuperOffice Customer Service module is not yet available in our online portfolio. This solution needs to be implemented on-premise or partner hosted. The power of our solution is that both the Sales & marketing solution and Service solution share the same customer database. Sales can get insights in service statuses and service can get insights in sales statuses. To be able to use both solutions to give access to all users throughout Europe. For On-Premise deployments we also provide monthly payment plans comparable to cloud pricing. We don't fill out these types of inquiries, unless we are connected directly with the project. We can certainly talk to you about the project if you would like. Please let us know if this is something you would like move forward with.																							
<u>8</u> 9 10 11	SysAid Technologies Ltd. ZoHo Corporation Superoffice Desk.com	Please see attached PDF for Our cloud DRP YES, HTTPS://WWW.ZOHO.COM/SECURITY. HTML ISO 27001, SAFE HARBOR, SSAE16 SOC1 TYPE II, SAS70 TYPE II & FISMA . View more here on mirosoft website. (http://www.mirosoft.com/online/lega I/v2/en-	Solutions for organizations of all sizes, SysAid is deployed at companies in multiple industrie, from smaal and medium-sized businesses to fortune SOO companies alike. ZIE EMAIL: Tennant is implementing SuperOffice Sales & Marketing Online. Our SuperOffice Customer Service module is not yet available in our online portfolio. This solution needs to be implemented on-premise or partner hosted. The power of our solution is that both the Sales & marketing solution and Service solution share the same customer database. Sales can get insights in service statuses and service can get insights in sales statuses. To be able to use both solutions on one database your solution needs to be moved on-premise. We deliver secure solutions to give access to all users throughout Europe. For On-Premise deployments we also provide monthly payment plans comparable to cloud pricing. We don't fill out these types of inquiries, unless we are connected directly with the project. We can certainly talk to you about the project if you would like. Please let us know if this is something you would like move forward with. Please view our website for more information about @work management. We are a microsoft gold partner and a microsoft president's club member																							
8 9 10 11	SysAid Technologies Ltd. ZoHo Corporation Superoffice Desk.com @work management associates	Please see attached PDF for Our cloud DRP YES, HTTPS://WWW.ZOHO.COM/SECURITY. HTML ISO 27001, SAFE HARBOR, SSAE16 SOC1 TYPE II, SAS70 TYPE II & FISMA . View more here on mirosoft website. (http://www.mirosoft.com/online/lega I/v2/en- us/MOS_PTC_Security_Audit.htm)	Solutions for organizations of all sizes, sysAid is deployed at companies in multiple industrie, from smaal and medium-sized businesses to fortune 500 companies alike. ZIE EMAIL: Tennant is implementing SuperOffice Sales & Marketing Online. Our SuperOffice Customer Service module is not yet available in our online portfolio. This solution needs to be implemented on-premise or partner hosted. The power of our solution is that both the Sales & marketing solution and Service solution share the same customer database. Sales can get insights in service statuses and service can get insights in sales statuses. To be able to use both solutions on one database your solution needs to be moved on-premise. We deliver secure solutions to give access to all users throughout Europe. For On-Premise deployments we also provide monthly payment plans comparable to cloud pricing. We don't fill out these types of inquiries, unless we are connected directly with the project. We can certainly talk to you about the project if you would like. Please let us know if this is something you would like move forward with. Please view our website for more information about @work management. We are a microsoft gold partner and a microsoft president's club member for CRM																							
8 9 10 11	SysAid Technologies Ltd. ZoHo Corporation Superoffice Desk.com @work management associates	Please see attached PDF for Our cloud DRP YES, HTTPS://WWW.ZOHO.COM/SECURITY. HTML ISO 27001, SAFE HARBOR, SSAE16 SOC1 TYPE II, SAS70 TYPE II & FISMA . View more here on mirosoft website. (http://www.mirosoft.com/online/lega I/v2/en- us/MOS_PTC_Security_Audit.htm) EU SAFE HARBOR compliant + SSL	Solutions for organizations of all sizes, SysAid is deployed at companies in multiple industrie, from smaal and medium-sized businesses to fortune 500 companies alike. ZIE EMAIL: Tennant is implementing SuperOffice Sales & Marketing Online. Our SuperOffice Customer Service module is not yet available in our online portfolio. This solution needs to be implemented on-premise or partner hosted. The power of our solution is that both the Sales & marketing solution and Service solution share the same customer database. Sales can get insights in service statuses and service can get insights in sales statuses. To be able to use both solutions to give access to all users throughout Europe. For On-Premise deployments we also provide monthly payment plans comparable to cloud pricing. We don't fill out these types of inquiries, unless we are connected directly with the project. We can certainly talk to you about the project if you would like. Please let us know if this is something you would like move forward with. Please view our website for more information about @work management. We are a microsoft gold partner and a microsoft president's club member for CRM																							

Q 14 15 16	UserScape inc OKM GESTION DOCUMENTAL Radgost SP. Z o. o.	NO, but you would provide those as we're not a SaaS. You can install helpspot on your own servers or on a third party server and use your own security certificates YES, provided by hosting supplier located in Germany YES	We created a customized CRMdesk Customer support system for your review, this is not a demo- it is a fully- functioning production helpdesk system ready for an immediate usage. CRMdesk consists of TWO separate web-based applications: Support desk is an easy to use web application to empower your company's support staff for effective managing customer's questions and updating FAQ knowledge base. AND CUSTOMER DESK (the system that will serve your customers): http://tennantco.crmdesk.com To be able to "Ask a Question" first-time users have to "Create New Account". The system requires initial registration in order to keep customer questions separate and confidential. No registration is required for searching public FAQ knowledgebase. Customers may submit their question or request. All customer requests are grouped and organized to allow easy review and dialog with support staff. Customer Desk can match your company's website natural look and feel. We offer FREE appearance integration with your website assistance. Please	
			Customer Desk can match your company's website natural look and feel. We offer FREE appearance integration with your website assistance. Please reply to this notification and provide the link to your company's web page which appearance you would like us to match. The only thing your webmaster needs to do is to link your website's support menu item to your new Customer Desk: http://tennantco.crmdesk.com	
17	ForeSoft Corporation		Please feel free to ask any questions that you may have (you may always count on our unlimited customer support)	
1/		YES, and will be provided upon	n rease reel nee to ask any questions that you may have (you may arways count on our uninnited customer support).	
18	Vivantio Ltd	request		
19	Cynergy Software	YES		
		YES, we do have the security white		
	Kayako Help Desk Private	papers for our cloud service which		
20	Limited	will be sent along with the e-mail.	No forum functionality incorporated, however it can be added by a link and get your own Forum.	
21	Yellowfish Software	YES		

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	/ /	ie cr		
		for th		
	Je Je	lave tes ,		1
	Nar	our, fifica cep		/
	/ Yue	erti o	1.2	[
1	du			
5	/ 3	/		
			With SugarCRM, Tennant Company can:	
			* Improve its high quality one and done service (applies to both customers and service engineers) via for example intelligent ticket routing	
			comingurable worknows), ucket instory and adult train and a sen service portar; * Increase the productivity of the technical support agents via for example FAOs a knowledge base, seamless CTL a 360 degree customer view email	
			notifications and an end user configurable desition:	
			* Provide real time service and support visibility via end user defined dashboards and reports.	
			A good example of one of the benefits is a statement by Siddhart Thakur who is CTO of Techlive Connect: "TLC Remote Support Technicians Save	
			Hundred Of Hours Per Week With SugarCRM"	
			PS: our solution is available in 28 languages and any Tennant Company specific fields can be easily translated in other languages.	
			A trial version of our application is available at http://www.sugarcrm.com/weborr/ity-sugarcrm-ree, but we are more than willing to demonstrate	
			and compare a more remain spectric environment diacadulesses your business chanenges and needs.	
22	SugarCRM inc.	SAS 70 TYPE II / ssae 16 Type II	We are looking forward to the next step in the selection process!	
			We have had no staff turnover since our inception in 2002. We have a very high renewal rate on our (mostly) month-to-month contract terms. Longer-	
			term contracts are also available.	
			Complete eService suite includes a community knowledge base for private/public/limited content, reputation engine, case management, feedback	
			management, online reporting & dashboards, and Fuze Social (similar to online communities) – all components tightly integrated.	
			We provide the Fuze suite to companies of all sizes and in many different industries. Some of our clients include: Dell, Expedia (including 28 Language). Conceptibility OHELINOAA All the and figure in figure in the suite and the deliver in the decision process	
			Taiguages), caree burder, Onso, Novo, Avo Clubs, and mancial institutions. we will grady provide contact micrimation as the decision process	
			Remarks:	
			A. You can run the Fuze Suite hosted on our servers or license it to run on Amazon or your own servers. Easily moved from hosted to licensed with	
			less than 1 hour downtime.	
			B. The Fuze Social module includes components for community answers, ideas and conversations and our reputation engine is built in to motivate,	
		Our bested environment runs -t	recognize & reward participation. It's integrated with the knowledge base and case management so unlike typical discussion forums, we make sure	
		internan (www.internan.com) bas	Unal people get their questions answered and that valuable answers can be curated in the knowledge base for future reference.	
		undergone a security review by	Twitter.	
		salesforce and is SAS70 / SOC 2	D. FuzeDigital has a patented reputation engine that ensures that you are engaging staff and others to share their knowledge to improve and grow the	
23	Fuze Digital Solutions, LLC	compliant	knowledge base content. We are the only ones to have built a reputation engine into the knowledge base.	
			Remarks:	
			With regard to the ticketing question above, Moxie provide integration options to third party Service tools such as Remedy, Salesforce.com,	
			Microsoft Dynamics, SAP, Oracle and so on via Spaces Connect. Spaces Connect is a comprehensive framework that effectively integrates	
			Information from across the enterprise. Its secure APIs and pre-built connectors make it easy to integrate Spaces by Moxie with other applications.	
			Reconcile	
		Moxie utilizes sunGard for OnDemand		
		infrastructure. SunGard has	Language translation can be provided by a partner. Further scoping would be required to ascertain the exact requirement and expand on the use	
24	Moxie Software Limited	performed and achieved SAS-70.	cases	
		YES, NEN 3140, 1010 AND 50110 1014,		
		BORG CLASS 4, ISO 27001:2005 and		
25	TOPdesk	SAS 70, PCI DDS, ISO 9001:2008	See document of TOPdesk	

Appendix VIII: Weight factors and Score of Vendors

The table below depicts the weight factors assigned to the different functions discussed in the questionnaire. A weight above 1 indicates highly important. Exactly 1 means important. Less than 1 means less important. These factors are determined based on the interviews with the stakeholders. On the next page, the score for the vendors is indicated based on the weight factor and the response of the vendor on the question in the questionnaire.

Question	Weight					
Is the software provided as a Service (SaaS) or On-Demand?						
Ticketing?						
a Knowledge base?						
a discussion forum?						
a Self-service portal?	2					
multiple access levels?	1					
full-text searching?	1					
searching by drill-down categories?	0,5					
a search function with filtering options?	0,5					
Notification messages?	1					
Subscription to topics?	0,25					
the rating of knowledge items (feedback)?	1					
configurable workflows?	0,75					
functions for translating languages?	0,25					
customizable e-mail forms?	0,75					
Frequently Asked Questions?	1					
automatically create/suggest Frequently Asked Questions?	0,5					
creating Wiki's?	0,5					
a file repository?	1					
a user-defined interface?	0,5					
The software is capable for using multiple discussion forums?	0,75					
The software is capable for sending notification messages from a discussion forum?	0,75					
Do you offer a trial version of the software?	1					

RANK	Company	Score
1	TeamSupport.com	22
2	ZoHo Corporation	22
3	Freshdesk inc	22
4	OKM GESTION DOCUMENTAL	22
5	Cynergy Software	21,75
6	ForeSoft Corporation	21,5
7	Fuze Digital Solutions, LLC	21,5
8	Zendesk	21,25
9	Radgost SP. Z o. o.	20,75
10	SugarCRM inc.	20,75
11	Vivantio Ltd	20,5
12	SysAid Technologies Ltd.	20
13	Kayako Help Desk Private Limited	19,75
14	Moxie Software Limited	19,75
15	Saveharbor Knowledge Solutions	19,5
16	@work management associates	19,5
17	Inflectra Corporation	19
18	TOPdesk	18
19	Superoffice	17,25
20	Yellowfish Software	16
21	SmarterTools	15
22	UserScape inc	13,75
23	BlueCamoo, Inc.	13,25
24	Visionflow	0
24	Desk.com	0

Appendix IX: Scenario for the Hands-on session

There are two versions. One for customer and technical support employees and one for service. This is because the different stakeholders have different requirements and need different functions from the system.

Scenario for Customer and Technical Support (CPE and Training):



[Your Email address]

Priority: Low

Serial: M7300545471

Question:

Hi, I have a Tennant 7300 machine and recently the batery was disconnected and now the clock has reset. How do change the time?

Task 3



Handle another two tickets that are open in the inbox. If the answer is unknown from the knowledge base, try to find the answer in the old way and add the new knowledge to the knowledgebase.

Task 4



Write yourself a knowledge article in the system and attach a picture to it. Publish the item.

Check out other functions within the system:

Try the system and look for missing features. Try also the:

Customer Portal	Ask question on Forum	Add FAQ	Place comments
Do not hesitate if you h	ave any questions or remark	<s.< td=""><td></td></s.<>	

Scenario for Service:

Service Evaluation Scenario

You will start at the customer home page. To go to a protected section you have to log in first. I have created an account for you based on your Tennant e-mail address. It is possible that you have had some activation e-mails already

Task 1: Ask Question

Ask a question at the support forum via the request forum. It may be any question.

Task 2: Ask a Question via the forum

Create a question at the forum section and create a support ticket by sending a notification to the support crew.

Task 3: Search Forum / Knowledge Base

Search in the discussion forum or knowledge base.

Questions:

- 1. You have a T3 with a water issue. Search for solutions
- 2. You have 7300 and you want to know how to set the clock. Search for solution
- 3. Failure of ec-H2O module

Task4: Answer questions on the forum

Try to answer the questions that are in the forum section. (if any)

Task 5: Evaluation

Please assess the functionalities of the portal based on the assessment forum.

Appendix X: Evaluation form for Hands-on Session

There are two versions, one for Customer/Technical support and one for Service.

Stakeholder Assessment Form Customer Support/Technical Support

Name System:										
Score: 1 = Completely Disagree 5 = Completely Agree										
I thought the system was easy to use.	1	2	3	4	5					
The system has a clean and simple presentation.	1	2	3	4	5					
I enjoy using the system.	1	2	3	4	5					
I needed to learn a lot of things before I could get going with this system.	1	2	3	4	5					
This product improves my job performance	1	2	3	4	5					
Using this product gives me greater control over my work.	1	2	3	4	5					
I am able to find what I need quickly on this website.	1	2	3	4	5					
I think that I would need the support of a technical person to be able to use this system.	1	2	3	4	5					
This product supports critical aspects (case handling, knowledge management, collaboration)	1	2	3	4	5					
I found the various functions in this system were well integrated.	1	2	3	4	5					
I found the system unnecessarily complex.	1	2	3	4	5					
I would imagine that most people would learn to use this system very quickly.	1	2	3	4	5					
I felt very confident using the system.	1	2	3	4	5					
Overall, I find this product useful in my job.	1	2	3	4	5					

Name System:										
Score: 1 =	Extremely Di	ssatisfied			7 =	Extre	emely	/ Satis	sfied	
Handling Cases?			1	2	3	4	5	6	7	
WHY / FEEDBACK:										
Using Knowledge Base?	•		1	2	3	4	5	6	7	
WHY / FEEDBACK:										
Using Forum?			1	2	3	4	5	6	7	
WHY / FEEDBACK:										
FAQ / Ask Question?			1	2	3	4	5	6	7	
WHY / FEEDBACK:										
	_									
	e?		1	2	3	4	5	6	7	
WHY / FEEDBACK.										
			4	<u> </u>	<u> </u>				7	
			1	2	3	4	5	Ь	/	
	ΙΑΚΝΟΪ									

Service Assessment Form for Service Engineers / Supervisors

Name System:										
Score: 1 = Completely Disagree 5 = Completely Agree										
I thought the system was easy to use.	1	2	3	4	5					
The system has a clean and simple presentation.	1	2	3	4	5					
I enjoy using the system.	1	2	3	4	5					
I needed to learn a lot of things before I could get going with this system.	1	2	3	4	5					
This product improves my job performance	1	2	3	4	5					
I am able to find what I need quickly on this website.	1	2	3	4	5					
I think that I would need the support of a technical person to be able to use this system.	1	2	3	4	5					
I found the various functions in this system were well integrated.	1	2	3	4	5					
I found the system unnecessarily complex.	1	2	3	4	5					
I would imagine that most people would learn to use this system very quickly.	1	2	3	4	5					
I felt very confident using the system.	1	2	3	4	5					
Overall, I find this product useful in my job.	1	2	3	4	5					

Name System:										
Score	e: 1 = Extremely	Dissatisfied			7 =	Extre	emely	/ Satis	sfied	
Using Knowledge E	Base?		1	2	3	4	5	6	7	
WHY / FEEDBACK:		I								
Using Forum?			1	2	3	4	5	6	7	
WHY / FEEDBACK:										
FAQ / Ask Questio	n?		1	2	3	4	5	6	7	
WHY / FEEDBACK:										
General User Expe	rience?		1	2	3	4	5	6	7	
WHY / FEEDBACK:										
Overall Score:			1	2	3	4	5	6	7	
WHY / FEEDBACK /	REMARKS:									

Appendix XI: Evaluation results of systems

The tables in this appendix display the results and feedback from the hands-on session by the stakeholders of the technical support process.

				Score			Rea (inv nece	alsco verteo essar	re d if ˈily)
			Freshdesk	Teamsupport	ZoHo	Inverted question?	Freshdesk	Teamsupport	гоно
Туре	ID	Questions							
CS/TS/S	1	I thought the system was easy to use (5)	4,0	3,7	3,0	0	4,0	3,7	3,0
CS/TS/S	2	The system has a clean and simple presentation (5)	4,0	3,6	2,7	0	4,0	3,6	2,7
CS/TS/S	3	I enjoy using the system (5)	4,1	3,6	2,2	0	4,1	3,6	2,2
CS/TS/S	4	I needed to learn a lot of things before I could get going with this system (5)	2,7	3,1	3,7	1	3,3	2,9	2,3
CS/TS/S	5	This product improves my job performance (5)	4,0	4,3	3,2	0	4,0	4,3	3,2
CS/TS	6	Using this product gives me greater control over my work (5)	3,6	3,6	2,5	0	3,6	3,6	2,5
CS/TS/S	7	I am able to find what I need quickly on this website (5)	4,0	3,1	3,3	0	4,0	3,1	3,3
CS/TS/S	8	I think that I would need the support of a technical person to be able to use this system (5)	2,3	2,9	3,3	1	3,7	3,1	2,7
CS/TS	9	This product supports critical aspects (case handling, knowledge management, collaboration) (5)	4,0	4,0	3,8	0	4,0	4,0	3,8
CS/TS/S	10	I found the various functions in this system were well integrated (5)	3,9	3,4	2,8	0	3,9	3,4	2,8
CS/TS/S	11	I found the system unnecessarily complex (5)	2,3	2,4	3,5	1	3,7	3,6	2,5
CS/TS/S	12	I would imagine that most people would learn to use this system very quickly (5)	4,1	3,7	3,2	0	4,1	3,7	3,2
CS/TS/S	13	I felt very confident using the system (5)	4,3	4,0	3,3	0	4,3	4,0	3,3
CS/TS/S	14	Overall, I find this product useful in my job (5)	4,1	4,0	3,2	0	4,1	4,0	3,2
CS/TS/S	15	Handling Cases? (7)	5,4	5,6	4,3	0	5,4	5,6	4,3
CS/TS/S	16	Using Knowledge Base? (7)	5,4	5,9	4,5	0	5,4	5,9	4,5
CS/TS/S	17	Using Forum? (7)	6,0	5,3	3,7	0	6,0	5,3	3,7
CS/TS/S	18	FAQ / Ask Question? (7)	6,2	5,0	3,8	0	6,2	5,0	3,8
CS/TS/S	19	General User Experience? (7)	5,4	5,0	4,2	0	5,4	5,0	4,2
CS/TS/S	20	Overall Score: (7)	5,7	5,6	3,8	0	5,7	5,6	3,8

Feedback on Freshdesk Feedback Handling cases Many Scrolling Required, • Overale Fine, but requires more time to get used to it Feedback using knowledge base: Special combination text and illustration/pictures Once it is built and info is there and you know how to use it will get better, but starting out, difficult Is nog moeilijk te beoordelen want er staat nog niet veel in Makkelijk zoeken op trefwoorden Feedback using forum Good combination of different country platforms Ik vind het lekker duidelijk en er zijn meerdere mogelijkheden om een ticket te maken Krijgt gelijk een e-mail ter bevestiging van... Goeie feedback Feedback FAQ/ask guestion Search tool leads quick to results Bij een deel ingevuld van het probleem krijg ik al antwoord • Database nog niet gevuld maar makkelijk toegang Feedback on General user experience Layout is simple and easy to overlook multiple languages • Not my favorite Fijn en makkelijk te gebruiken en Nederlands Simpel, makkelijke bediening Feedback on overall score I would learn to use it if I had to, to became good, but still don't like it Ik denk dat ook onervaren mensen hiermee uit de voeten kunnen Feedback on Teamsupport Feedback Handling cases Deviated from existing inqury Feedback using knowledge base: Excellent. Many options many approach/selection Easy to find information Ik vind het niet erg overzichtelijk Duidelijk overzicht, makkelijke zoek functie Feedback using forum Combination of the 2 levels: General + Country

- Wel prettig dat het per land gespecificeerd is
- Goed overzicht, ook makkelijk om bijlage toe te voegen

Feedback FAQ/ask question

- / searchtool
- Het systeem komt niet snel met resultaten. 1 Fout getypte letter = geen antwoord
- De zoek machine werkt goed

Feedback on General user experience

- / searchtool
- Overall this is my favorite
- Toch onduidelijk
- Mooi systeem

Feedback on overall score

Best application next to hits at search tool

- Will be the easiest to learn
- Ik heb hier niet echt overzicht
- Overzichtelijk en makkelijk in gebruik

Feedback on Zoho Support

Feedback Handling cases

JE verliest het overzicht vanwege het nieuwe open van blad

Feedback using knowledge base:

- Ik vind het niet erg overzichtelijk
- Goed overzicht vanuit home page, makkelijk te vinden

Feedback using forum

- Alles in het Engels
- Veel tab bladen en mogelijkheden. Niet overzichtelijk

Feedback FAQ/ask question

- Goed te gebruiken, maar waarom moet er serienummer worden genoteerd
- Product name?

Feedback on General user experience

- Very user friendly approach
- Het vele engels maakt het lastig
- Redelijk complex, wel heen veel mogelijkheden

Feedback on overall score

Results:

- Better feeling of other systems
- Voor de wat ervaren computergebruiker wel een mooi systeem, maar de wat onervaren mensen zijn snel de weg kwijt.
- Zeer uitgebreid met (te)veel mogelijkheden

Freshdesk Teamsupport ZoHo Usablity (Q1,Q3,Q7,Q11,Q13) 4,0 3,6 2,9 Increase job performance (Q5,Q6,Q14) 4,0 3,9 2,9 Start using system (complexity) (Q4, Q8, Q12) 3,7 3,2 2,7 System functions (Q2, Q9, Q10) 4,0 3,7 3,1 Average (Q1 – Q20) 3,9 3,6 2,9 Handling cases 5,4 5,6 4,3 Knowledge base 5,4 5,9 4,5 Forum 6,0 5,3 3,7 FAQ/Ask Questions 6,2 5,0 3,8 General user experience 5,4 5,0 4,2 **Overall score** 5,7 5,6 3,8

Appendix XII: Comparison chart for selecting system

This appendix illustrates a comparison chart of the top 3 systems, Freshdesk, Teamsupport and ZoHo support.

System name:	Freshdesk	TeamSupport	Zoho Support
Version	Garden Plan	Enterprise	Zoho Support Professional Edition
	A		
		100 Highland Park Village Suite	
Location	340 S Lemon Ave #7585 Los Angeles, CA, 91789, USA	100 Dallas, TX 75205 Verenigde Staten	4900 Hopyard Rd Suite 310Pleasanton, CA 94588 Verenigde Staten
Founded	2010	2008	1996
Employees	11-50	11-50	1001-5000
Awards	Winner of the Microsoft BizSpark Startup 2011 award	Best of SaaS Showplace, MSI Support Excellence, TMC CRM Excellence	Web Host Magazine & Buyer's Guide - Editors' Choice for January 2010, InfoWorld's 2009 Technology of the Year Awards, Top 10 International Products of 2008 - by readwriteweb, The 101 most useful websites : No 5 Zoho by Telegraph.co.uk
	⁻	↓ ′	·
Security			
Hosting party	Engine-yard	Colo4	
SafeHarbour EU-US	YES	YES Muroc Systems performs self assessment yearly	YES
TRUSTe	NO	NO	YES
SSL-encryption	YES	YES 128-bit	YES, 128/256-bit
SAS 70 Type II certified	YES	YES	NO (but intended, no time line)
ISO 27001	YES	NO	NO
Website	http://www.engineyard.com/products/managed/infrastru cture	http://www.colo4.com/	
Reliability			
Availability Last month	99,894%	99,960%	99,420%
Availability Last 3 months	99,730%	, 99,940%	-
Availability Last 12 months	-	99,946%	99,830%
Response time		,	1,381 ms Netherlands, Average 700ms

System name:	Freshdesk	TeamSupport	Zoho Support
Version	Garden Plan	Enterprise	Zoho Support Professional Edition
Functionalities			
	Email Ticketing and automatic email-to-ticket		
	conversion	Multi-time zone support	Product based Request Tracking
	Separate Knowledge base	reporting	Task Assignment
	Customizable Self Service Portal	SLA management	Request-level Time Tracking
	Automatic ticket prioritization, categorization and		
	assignment through Dispatch'r	Wiki	Contacts & Accounts Management
	Business rules management with Supervisor	WaterCooler	Email Address for Tracking Requests max 10
	One-touch Scenario Automation for repetitive tasks	Live Chat	Customer Portal
	Default SLA Policy management with business hours		
	and holidays	Custom fields	Web-to-Request Form max 10 forms
	Basic Reporting	Custom Workflow	Twitter (Unlimited Accounts)
	Integrations: Jira, SugarCRM, CapsuleCRM, Google		
	Contacts, Gmail Gadgets, Google Analytics, Zopim,		
	Olark, Shap Engage, HelpOnClick	Custom Properties	Facebook (Unlimited Accounts)
	summary	Custom Tickota	
	Support through unlimited Twitter accounts	Tielet externation	Number of Solution Folders
	Support through multiple Eaceback pages		Number of Solution Folders = Onlinitied
	Community forums including Q & A Ecodback and	File Attachments	
	Idea management	Ticket Queue	Public & Private Solutions
	Ticket-level time-tracking and customizable time-		
	spent reports	Ticket Tagging	Solution-to-Article Conversion
	Customer satisfaction surveys & reports	Familiv Tickets	No of Portal Users = unlimited
	Integrations: Harvest Freshbooks WorkflowMax	Email integration	Custom Themes
	Reports: Time sheet report. Customer satisfaction		
	report	Knowledge Base	Custom Widgets
	Ability to support multiple products from a single		
	Freshdesk account	User groups	Domain Mapping
	Advanced reporting	Ticket submission portal	Remote Authentication
	Multiple SLA policies	Advanced Customer Portal	Multi Language Support
	Multi Time Zones	API	Set your Time Zone
	All Integrations	CRM Integration	No of Departments max 10
	Reports: Helpdesk activity report, Customer activity		
	report	Source control integration	Workflow Rules = 5/department/module
		Customers & Contacts Database	Time Based Rules = 10/department/module
		Products & version tracking	Request Assignment Rules = max 10 rules
		Inventory & asset tracking	Macros = 20/department/module

System name:	Freshdesk	TeamSupport	Zoho Support
Version	Garden Plan	Enterprise	Zoho Support Professional Edition
Functionalities			No. of SLAs = 5/department
			Multi-Level Escalations
			Business Hours & Holiday List
			Customize your Tabs & Fields
			Custom E-mail Templates
			Canned & Custom Reports
			Standard & Custom Dashboards
			Export Reports to CSV, XLS or PDF
			Profiles max 15
			Roles max 5
			Field-level Access Control
Reporting opportunities	Agent Ticket Summary	Many different reporting options	Customer and contact person report
	Group Ticket Summary	- Tickets	Product reports
	Time sheet Report	- Knowledge items	Request reports (Tickets)
	Customer activity report	- Performance	Solution report (Knowledge base)
	Helpdesk activity report	- etc.	Task Report
	Customer satisfaction report	Able to create own report	Able to create own report

System name:	Freshdesk	TeamSupport	Zoho Support
Version	Garden Plan	Enterprise	Zoho Support Professional Edition
Alert on knowledge item with certain			
date	NO	Yes, via workflow or reminder on item	YES, via workflow
Data storage limitation?	No limit	No limit	No limit
Cost extra storage?	None	None	none
Export data knowledge base possible?	YES	YES	YES
Export format?	XML format	.csv format	.csv format
Connect Phone To System	Working on it	Plans are there.	YES extra for 6 dollar/user /month
Customized system interface?	YES	NO	NO
Customized Support Portal?	YES	Yes by coding	YES
Customized Public portal?	YES	Yes by coding	YES
			English, Spanish, German, French, Portuguese, Russian (some
	Dutch, English, French, German, Spanish, Portuguese,		words are in Dutch in the portal but not all, they are trying to
Languages System	Czech	English	create it with Unicode)
			Only address it on predefined language of above based on user
Language Support portal	Based on browser settings	Based on Google Translate and browser settings	settings.
Associate products to customers	NO	YES	YES
Products	YES, support for different products	YES	YES
		Knowledge can be available on whole portal. You can	
		choose to give access to non registered users to	
Access knowledge portal	Chose to share categories based on registered or not	knowledge base or not (entire)	You can choose if a article is public for all or only registered
Feedback Tickets	YES	NO	NO
Feedback Forum	NO, only comments and can close discussion	NO	YES
Feedback knowledge Item	YES	YES	NO, only comments
Chat function	NO	YES	YES
Notification of new topic on forum	Working on it (now to email, not as ticket) (2-3 months)	YES	YES
User Feedback			
(out of 5)			
Usablity	4,0	3,6	2,9
Increase job performance	3,9	4,0	2,9
Start using system (complexity)	3,7	3,2	2,7
System functions	4,0	3,7	3,1
Average of above	3,9	3,6	2,9
(Out of 7)			
Handling cases	5,4	5,6	4,3
knowledge base	5,4	5,9	4,5
Forum	6,0	5,3	3,7
Ask question	6,2	5,0	3,8
General user experience	5,4	5,0	4,2
Overall score	5,7	5,6	3,8

System name:	Freshdesk	TeamSupport	Zoho Support
Version	Garden Plan	Enterprise	Zoho Support Professional Edition
Customer references			
Website	Toshiba, Pixavi, Indiamart, Hellotravel.com, Stanford sch	GridPoint, Javelin, AT&T, Fujifilm, ATPA, Talon Data	IKEA ,Hp Fortified on Demand &PESA CAT
Nederland	Pearson Publishing	FEET	Zermelo, Expansion, Verum, Vabi
	Company: Pearson		
	Name: Matthijs Lok		
	Contact Number: 31.20.5815564	company is called FEET and my contact there	
Referential	Email: matthijs.lok@pearson.com	is Remko.vdBoogaart@feet.nl.	
Implementation cost/time			
			As regards implementation, there is no charge as we
			assist on it during the evaluation stage. Next to that it
Time for implementation (user)	Ready to use	Ready to use, at most a week, depends on customer	is ready to use
Implementation package (company)	-	-	
Training / demo session	YES, Demo	YES, Training	Yes, Online training, desktop sharing
Who	All Agents	Partial groups of agents, multiple sessions	5 attendees
Duration	2 hours	1 hour	90 minutes
Cost	Free	Free	\$250
Support from provider	24/7	Email	Blog
	Blog	FAQ	Email
	Brochures	Forums	FAQ
	Email	Help Desk	Forums
	FAQ	Knowledge base	Instructional Videos
	Forums	Live chat	Knowledge base
	Help Desk	Online self serve	Online self serve
	Instructional Videos		Owner's/User Manual
	Knowledge base		Phone
	Normal business hours		Remote Training
	Online self serve		Request form
	Owner's/User Manual		
	Phone		
	Recorded demos		
	Remote Training		
	Request form		
	Tips and hints		
	Webinars		
	White papers		

System name:	Freshdesk	TeamSupport	Zoho Support
Version	Garden Plan	Enterprise	Zoho Support Professional Edition
Cost of system			
Number of users	39 , 1 user is always free	40 users	40
Regular Price / agent / month	\$ 29,00	\$ 35,00	\$ 12,00
Regular Price / month	\$ 1.131,00	\$ 1.850,00	\$ 530,00
Regular Price / quarterly	-	\$ 4.320,00	\$ 1.590,00
Regular Price / biannual	-	\$ 8.640,00	\$ 3.180,00
Regular Price / Year	\$ 13.572,00	\$ 17.280,00	\$ 5.724,00
Extra cost	-	Webform, quartly: 40 dollar, month: 50 dollar	\$ 10 per discussion forum / month (need one per country I think)
Special Discount	Because looking for 40 users = 15% discount on monthly	-	
Special Price / agent / month	\$ 25,00	-	
Special Price / month	\$ 975,00	-	
Special Price / Year	\$ 11.700,00		10% discount on yearly basis (already standard in regular price)
EXTRA	They offer day-pass access for 2 dollar a day	Need to pay extra for portal	There is also an enterprise edition with som additional features for 25 dollar / agent / month incl

Appendix XIII: Knowledge Article Template

In this appendix the knowledge article template is illustrated, to submit knowledge in the knowledge base. With this template the knowledge is structured in a standard format, which makes it easy for the knowledge user to assess the relevance of the knowledge item.

	TENNAM
Tennant Company –	- Knowledge Article Template
Knowledge A	rticle Template
This document prov aspects of a high qu relevance by a know	rides a pre-defined structure of a knowledge article, which captures all relevant ality knowledge article. The goal of this structure is to improve the assessment of vledge user, and knowledge is found quickly. Feel free to insert images.
Date:	Creation Date
Model / Type:	Machine Model or type i.e.: T16, Orbio, Battery
Subject:	Subject i.e.: No water scrub head T16
Author:	Authors Name
Issue:	Describe the question or the problem
Conditions:	Conditions that are causing the issue
Solution:	Describe the solution for the issue described above, for the specified conditions. Describe also the diagnostic steps.
Solution Type:	Choose Type
Keywords:	Name relevant keywords. i.e.: ec-H20, overheating, belt

Appendix XIV: Response from Questionnaire

Respondent	Group	Mean old method	Mean new method
1	Service	3,6	4,4
2	Service	3,7	4,8
3	Customer Support	3,8	4,1
4	Service	3,8	4,7
5	Other	3,9	4,7
6	Service	4,1	4,4
7	Customer Support	3,5	3,6
8	Other	3,2	3,7
9	Other	4,3	4,2
10	Customer Support	4,1	4,2
11	Customer Support	3,2	3,6
12	Customer Support	4,4	4,7
13	Customer Support	3,7	4
14	Customer Support	3,7	3,8
15	Customer Support	3,6	4
16	Service	3,4	4,6
17	Customer Support	2,9	3,9
18	Customer Support	4,4	4,7
19	Other	2,5	3,2
20	Service	4,1	4,1
21	Customer Support	3,3	4,4
22	Customer Support	2,9	4,3
23	Service	2,4	3,6
24	Other	3,2	4,6

Appendix XV: Introduction and Questions for measuring quality improvement

Dear Sir/Madam,

This questionnaire contains 20 cases. A case exists of a question and answer to this questions by Technical Support (Europe). To help us improve the quality of the answers, please assess the quality of the answer provided by TS on the question. You can score the answer based on a scale from 1 (bad quality of answer) to 5 (good quality of answer).

Keep in mind:

Do not rate the answer on the fact that the solutions is not satisfying, i.e. "No we do not offer this option".

Assess the answer on factors which satisfy your criteria of a high quality answer, like if the answer clear, answers the question, is complete, well formulated, etc.

Your response is completely anonymous. We only would like to know from which department you are.

Kind Regards and Thank You!!

Stefan Melis / Technical Support Europe Tennant N.V.

Case	Method	Question	Answer Technical Support
1	Old	Is there a P/N for a connector of	I cannot find anything, but this machine is
		SORMA SM515?	out of service for a long time, so I expect that
			we do not have anything on stock.
2	New	please can you help me I require the	If you look on page 15 or 17(frame group)
		wiring loom that fit inside item 24 or	and then on the bottom of the list you see
		does the handle assembly come with	the harness.
		wiring loom inside aiready	2201/ 1022025
		(pin in handle assembly has shear and bandle bas turned, and sut off wiring)	230V 1033925
2	Νοω	For the 215E I need the part number for	120V 1053523
5	INCOV	the Honner switch that operates	3-9 in the manual with part number 63846
		the warning light on the dash	I made a copy of boew it looks like
		There are a few switches in the parts	let me know if this is not the one
		manual, but it's not clear which part	
		number is for the hopper.	
		Can you please advise the part number?	
4	New	Do you have a part number for a	The part number for the After Market T7
		complete disc scrub head (800mm) for a	800mm Disk scrubhead is 9000142.
		T7 machine including side squeegee	This has everything on it except the
		assembles?	squeegee blades and I think this is for if
			somebody have or need other blades.
			The normal standard blades
			are 86859 SQUEEGEE ASSY, SIDE [LINATEX]
5	Old	I m making an UPS express order for	Everywhere I look I see you need this filter
		mine technicians said that the oil filter	but I also found this in the old mails and it is
		that I previously ordered was wrong	dimensions (Attachment)
		The part No. is 372654, and I checked	
		the parts catalogue and it says it is for	
		machine with serial *** and above, and	
		our machine is 800-7748.	
		Can you please check this as soon as	
		you can, because I need those parts	
		here tomorrow and would like to	
		include this filter with it, so I need to	
		send the order right now.	
6	Old	Just off the back of this for the same	They are single fase.
		customer, can you confirm if we do a	About the 16 amp Commando plug, I never
		single phase charger for the S20 and	heard from it.
	NIa	what plug is 16 amp commando etc.	
/	New	Can you answer this question of a	what the customer needs is of a old 13 with
		customer? Thank you.	spline axie. The wheel with a spline axie is
		Message:	1010073.
		A customer wants to order a wheel of a	
		T3. The hub where the wheel is	
		mounted on is not tapered and this	

		machine has a spline axle. On internet	
		the customer founds there are two	
		different types, is that right?	
8	Old	The new 7300 we received was to go	I spoke O&C and they say everything is
		out on demo. Unfortunately there is a	within the specs. They and the Assembly
		bad noise in the chain drive for the	Engineers think that it is a wrong alignment
		main	from the chain and the sprockets, because all
			other parts are okay.
		Brushes. Listen to attached video. Looks	
		like the chain pitch and sprocket pitch	They spoke to the boys that they have to
		are not mating.	take care that they adjust it right.
		Pls can you check if this is an issue	Is it solved now with the originale parts or
		before we start reinventing the wheel	did they replace everything?
		here/	
9	New	T16 main contactor seems to have two	We (TNV) still are using up stock of the old
		part numbers / makes :	contactor. Once that is finished we will
			switch over to the new 200A contactor and
		1068510 – As per U.S parts manual –	the parts manuals will be updated.
		rated at 200A – make : AIVIETEK	
		1055056 – As per European parts	
		ALBRIGHT	
		ALDRIGHT	
		Could you confirm if the mistake is in	
		the manual and has not been updated?	
		We have recently ordered the old one	
		(1055056) and received it. Does the	
		American machines have a different	
		main contactor to the European ones?	
10	New	CAN YOU PLEASE GIVE ME THE PART	The battery kits for the 5100.
		NO OF THE 5100 BATTERY OR KIT	
			994230 BATTERY KIT, 0085AH [A, 5H, 5100]
			994238 BATTERY KIT, 0070AH [B, 5H, 5100]
			994230 BATTERT KIT, 0079AH [D, 5H, 5100]
11	Old	Our technician had big problems by	Sorry we don't have a tool for this. The best
		changing the old bearing Nr. 369319	way to do is to take a long pin and try it to
		of T15. They stood so tide, that it was	hammer it out from the inside.
		quite difficult to take them out.	
		Our question is: Have you a special	
		instrument for such cases? If yes - how	
		, can we get this.	
12	Old	I was at *** today, because the Orbio	I checked with ******, but for us this is the
		system keeps flowing water throughout	First time we hear this. Maybe **** gives a
		the drain. I started by checking the	reaction to your message.
		overflow, but there was no problem.	
		The water came from the water	
		softener, like it was continuously	
		regenerating. I operated the turn wheel	

		a few times and now the water flow	
		stopped.	
		Now my question did we have seen this	
		before that the watersoftener lingers in	
		the regenerate process?	
13	New	Can you inform me abouth the	This is not a hose.
		diameter of the hose with partnumber	
		73635.	73635 VR, HOUSING, THERMOSTAT [KU]
			This is the cover of the thermostat and on this part a base (55857) is used with a
			internal diameter of 31 75mm and on the
			other side a internal diameter of 25.40mm
14	Old	Could you forward any information to	This is what they send me.
		****** (copied) that we have on the	
		Co2 grams per KM for our Green	Message:
		Machines please?	
			HI,
			Lassume this is a 636
			The engine is certified to 97/68/EC Non Road
			Stage 3A and ECE R24 which is the correct
			standard for sub 37kW engines.
			Management Taget figures CO.0.9. NOULLICE 2
			Measured Test figures CO 0.8, NOX+HC 5.2, Particulates 0.27
			CO2 Emissions 4.9 gm/s in normal sweeping
			Regards,
15	Old	Hi All,	This is a machine that is already since 2010
		Is there a real according to riters 10050	out of service and we have no replacement
		2 Bellow you have the machine number	for this part.
		: bellow you have the machine number.	With kind regards.
		Thanks & Regards	
16	New	Could you please tell me if is available	There is no other wheel available for this
		some other front wheel for S8 then	machine,
		604130? Front wheel 604130 is from	
		rubber and it easily captures metal	If it happens more often please inform me.
		chips and totaly tear up after three	
		nlastic.	
17	New	do you have a MSDS for these kind of	here the MSDS for the TP version of Enersys
		batteries available?	wet batteries.
		Nr. 9002537 Kleintraktion 4X6V/210Ah	
18	Old	A customer has ordered kit 375430 but	For the 7100 we use the long tube 1014574
		the ETA is September 18th at the	(39 inch) for the FAST and ECH2O and for
		moment.	the standard you need 375426 (8 inch).

		Is this the right kit for the 7100?	The Part number you gave me was for a 7300/8300.
		The customer has also order motor 391296 for the same machine and this	The 391296 is a vacfan for the 7100.
		motor is for the 7100 in tech. docs.	
19	New	Is it possible to make the On Board Charger UK for the T7 run off 110V?	I looked it up in the Technical drawing and it say only 230V but to make sure I pulled one from stock and also the data plate say the same so 1032388 is only for 230V
20	Old	Can you please help me with the part no for the Alternator for 6650-10011 LPG GM Model?	You need 393209