Measuring the quality of a work schedule

Guidelines to develop a tool to evaluate work schedules

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Abstract

The present research is commissioned by Integral. Integral is a Dutch software company that develops employee scheduling software. The goal of this research is to formulate guidelines that can be used to develop a tool that will be able to evaluate work schedules. The guidelines are presented as a list of criteria. The content of the criteria is determined through a literature study and interviews.

The interviews are held with scientific experts (n=5) and practitioners (n=5). They are asked about what they thought were important aspects when evaluating a work schedule. Further questions were about the relative importance of these aspects. Regarding to the relative important of the different aspects, there was no general view. Therefore it is concluded that the importance can vary between organizations. The first design of the guidelines is tested through a pilot study. In this pilot study, work schedules of three organizations were evaluated with the help of organizations that use the scheduling software of Integral: Checks. After the pilot study, a few minor changes were made to the design.

The result of the present research is a set of guidelines to develop a tool to evaluate work schedules. The criteria listed are divided between six different categories: work-life balance, flexibility, health, legal regulations, predictability and finance. The evaluation of work schedules can be performed while looking from three different perspectives: the employee perspective, the organizational perspective and the customer perspective. To be able to use this tool, organizations have to follow three steps. Step 1: select criteria, step 2: give standards to criteria, step 3: weight criteria and categories.

Recommended is that the guidelines presented in the present research first have to be validated. Also, the scheduling program of Integral, Checks, has to be adapted if Integral intends to develop and integrate a tool using the guidelines presented here. There is some output that cannot be extracted from the schedules with the use of Checks, but which is needed to be able to get a valid evaluation.

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1. Introduction

A lot of organizations employ one or more planners to make work schedules. When scheduling employees, planners must determine how many employees perform certain tasks at a certain time. Beforehand, the planners must gather and weigh a lot of information and interests against each other. When an organization makes a schedule to plan their employees' working hours, a lot of things have to be taken into account (Van Wezel & Jorna, 2001).

The present research is commissioned by Integral, a Dutch software company. Integral develops employee planning software for organizations in the Netherlands called Checks. The director wanted to know how work schedules can be evaluated, so in the future they might be able to build a tool to evaluate work schedules.

But why is it important to be able to evaluate a work schedule? De Snoo, Van Wezel and Jorna (2011) state that managers would like to evaluate their work schedule. This way, it is easier to detect gradual changes in work schedules. In the Netherlands, it is a discussion that frequently came back in the last few years, due to an aging population and a higher retirement age (Goudswaard et al., 2013). Regarding that discussion, the health of the older employees can be of importance. But that is not the only priority. Satisfaction of the employees regarding to their work schedule is also important. The quality of a work schedule can be a reason to stay with a company or to leave. This can be of importance when the working population becomes smaller and employees become harder to find.

Worthen, Sanders and Fitzpatrick (1997, p8) define evaluation as "to determine the merit or worth of something". In the present research, guidelines to develop a tool will be formulated by which the value of a work schedule can be determined. These guidelines can be used to give an evaluation to work schedules. Because different stakeholders might be affected by a work schedule, the evaluation will be from different perspectives. When for example organizations evaluate work schedules on aspects only they are interested in, the interests of employees may be overshadowed. These guidelines can help to find a balance between stakeholders.

Some research is done to the evaluation of work schedules. De Snoo, Van Wezel and Jorna (2011) interviewed planners, managers and work schedule users to gain insight in the criteria that evaluate the quality of a work schedule. They presented a framework that includes a list of those criteria. Goudswaard et al. (2013) made, in cooperation with FME (a Dutch employers' organization in technological industry), a framework that showed that there are a lot of factors that influence each other. They built a research model that connected workplace, work schedule and individual indicators to health and productivity outcomes. Their research model was translated into a simplified dialogue model and a game, which can be used to start a discussion within an organization between actors involved. Verbiest et al. (2013) made a tool that focuses on how to make a work schedule in a way that has a more positive effect on the health of the employees. The output could either be that the standards of healthy work times are met, think of ways to improve this aspect, or the standards of healthy work times are not met. The tool is meant to be of help to a decision process to alternative work schedules (Verbiest et al., 2013). Another tool that is already in use is the Rota-Risk-Profile-Analysis (RRPA). This

tool focuses on the physical and social aspects that are influences by work schedules (Jansen & Baaijens, 2007). In contrast to the tool of Verbiest et al. (2013), the RRPA aims to quantify work schedule characteristics (Jansen en Baaijens, 2007). But both tools still have the restriction that they only focus on the health aspects of employees.

The present research aims to broaden the previous research. The ultimate goal is to formulate guidelines that can be used to develop a tool that will be able to evaluate work schedules on different aspects, not only health. With this tool, work schedules can be given a grade, so a gradual decline or progress can easier be detected. Verbiest et al. (2013) and the RRPA focused specifically on the health of the employees. But aren't there more aspects that influence how good a schedule is? Another extension is that the present research also looks at different stakeholders that might be influenced by a schedule. What, for example, might be good for an organization, does not necessarily have to be good for the employees.

The guidelines presented in this research can in the future result in an actual tool. When this tool would be available for organizations, they can evaluate their work schedules on different aspects and compare them with each other. Then they can see where the work schedule is weak and can be improved. This way, organizations can optimize their work schedule to fit with their needs and priorities. Comparing different work schedules from the past can be relevant, for example, to see whether there is a downwards trend or not.

1.1. Research questions

To be able to formulate guidelines to develop a tool, several questions have to be answered. The main research question that has to be answered is:

How can a work schedule be evaluated and which aspects are important to achieve this?

This leads to the following sub questions:

1. What are the criteria a tool must meet?
2. Who are relevant stakeholders that are influenced by a work schedule?
3. Which aspects influence the quality of a work schedule?

Not every aspect has to have the same impact on a schedule or is of the same importance. To give a proper evaluation to a schedule, the different aspects can be given a weight. This leads to the next research questions:

4. What is the relative importance of each aspect?
5. Does the importance of the aspects differ between different stakeholders?

To achieve the ultimate goal, to make guidelines that can be used to make a tool that will be able to evaluate work schedules on different aspects, the next research question has to be answered:

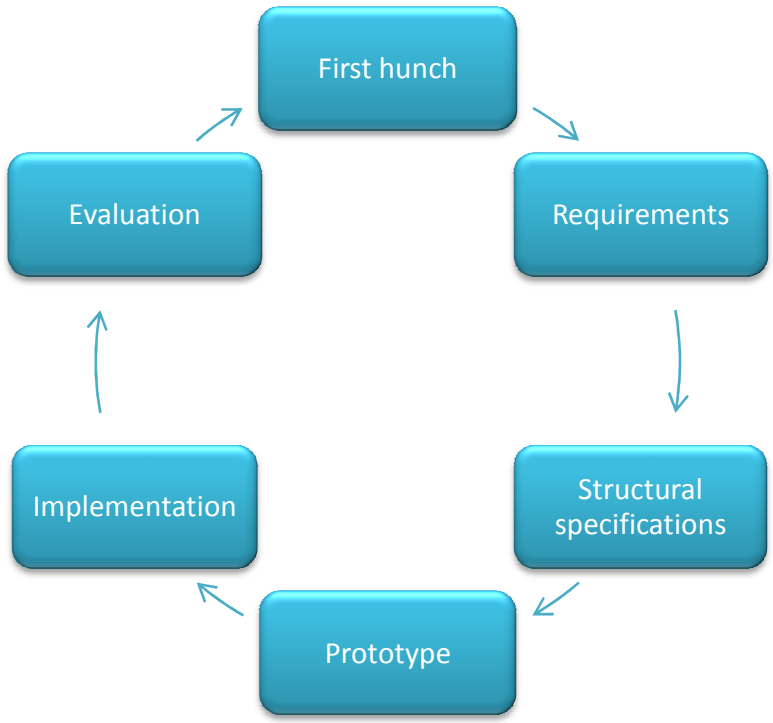
6. What are the guidelines that can be used to develop a tool that can evaluate work schedules?

1.2. Research design

This research aims to formulate guidelines to develop a new tool that can be used by organizations to evaluate their work schedule. Because it can result in a new product, this research is a design oriented research. To make sure the research is properly conducted, the steps from the designing cycle of Verschuren and Hartog (2005) (see figure 1) will be followed.

In the first hunch phase, problem identification is done by Integral. They commissioned this research to get insight in the criteria needed to evaluate a work schedule. Building on this idea, a research goal is formulated. In the requirements phase, first a number of requirements must be specified. Functional requirements are the functions the intended product should have to reach the formulated goal. User requirements are requirements that future users can have when using the intended product. Contextual requirements are limitations set by the environment. A literature study and several interviews will be held to perform the requirements phase. The literature study will be performed to get sufficient knowledge and is forming a foundation to the guidelines to develop a tool. After the literature study, interviews will be conducted to extend the information found in the literature and to get a different perspective on work scheduling. The interviewees will be several scientific experts and several practitioners. In the structural specifications phase, the results from the requirements phase will be used to make a first draft of the design. The information from the literature study and the interviews will be combined to come up with an idea for a design and the content of this design. In the prototype phase, a prototype of the design will be realized. A document will be created to manually evaluate work

Figure 1: The designing cycle (Verschuren & Hartog, 2005).



schedules. In the implementation phase, a pilot study will be performed in three organizations. Several work schedules will be evaluated using the first design. In the last phase, the evaluations phase, the pilot studies will be evaluated. Errors that may come up will be fixed and the final proposal will be presented.

The present research is commissioned by Integral, a Dutch software company with Dutch customers. That is why the research will focus on the Netherlands. This means that the focus of the interviews will lie on the Dutch market. Also, the Dutch legislation will be used.

The literature study is presented in chapter 2. Chapter 3 gives an overview of the methodology used to perform this research. Chapter 4 gives the results of the interviews that are conducted. In chapter 5, the design of the guidelines is presented. This chapter also contains the pilot test and the final proposal of the guidelines. The last chapter, chapter 6, gives a conclusion, recommendations and contains limitations of this research.

2. Literature review

To be able to formulate guidelines to develop a tool, first there has to be done research to functional requirements of a tool. Because how can one decide what should be the content of a tool, when it is not clear which form the content should have? That is why the first section of this chapter is a literature review about the tool design. The second section of this chapter is a literature review related to the content of the tool.

2.1. Tool design

To answer the question what characteristics a software tool must have, the ISO 9126 quality model can be used. The model consists of six quality characteristics: functionality, reliability, usability, efficiency, maintainability and portability (Losavia et al. 2004). The characteristics are described in table 1.

There are also some software criteria that need to be taken into account. This is because the end product of this research, the guidelines to a tool, must be applicable in practice. Integral commissioned that the guidelines must be able to count something. It is the most important software related restriction that is relevant to this research. This could mean that relevant information has to be excluded. Still, it is relevant to explore all the information available, to also be able to show which relevant information is missing.

Now the characteristics the tool must have are clear, the design of the tool must be explored. To do this, a few examples of tools are given to see how different tools are equipped. The first example is the Practice Guidelines Development Cycle of Browman et al. (1995). They wanted to make a tool that

Table 1: Characteristics of the ISO 9126 quality model

Characteristic	Description
Functionality	The capability of the software product to provide functions which meet stated and implied needs when the software is used under specified conditions (what the software does to fulfill needs).
Reliability	The capability of the software product to maintain its level of performance under stated conditions for a stated period of time.
Usability	The capability of the software product to be understood, learned, used and attractive to the user, when used under specified conditions (the effort needed for use).
Efficiency	The capability of the software product to provide appropriate performance, relative to the amount of resources used, under stated conditions.
Maintainability	The capability of the software product to be modified. Modifications may include corrections, improvements or adaptations of the software to changes in the environment and in the requirements and functional specifications (the effort needed to be modified).
Portability	The capability of the software product to be transferred from one environment to another. The environment may include organizational, hardware or software environment.

Source: Losavia et al. (2004).

facilitated the systematic development of cancer treatment practice guidelines. The tool was presented as a number of steps that had to be taken to produce guidelines. The steps are: select/frame clinical problem, generate evidence-based recommendation, ratify evidence-based recommendation, formulate practice guidelines, independent review, negotiate practice policies, adopt guideline, policies, schedules review. Because it is a cycle, the last step leads back to the first step. This is to update the guidelines and make sure they don't become obsolete (Browman et al., 1995).

The second example is the Employability Skills Assessment Tool. The function of this tool is to select the best candidate in a selection procedure. All candidates will get scores and the candidate with the highest score will get the job. The Employability Skills Assessment Tool is designed using a number of steps: identifying items, weight factor, determining skills score and validate tool (Rasul et al., 2012).

The third example is the School-Wide Evaluation Tool (SET). This tool is used to assess school-wide positive behavior support. It consists of 28 items that are divided in 7 categories. Each of these items could get a score of 0, 1, or 2. Then the scores of the 7 categories and the total summary score can be calculated (Horner et al., 2004).

2.2. Tool content

In the literature, different researches focus on different perspectives. But which perspectives are important? The stakeholder theory of Mitchell, Agle and Wood (1997) states that the most important stakeholders are the ones who have three key features: power, legitimacy and urgency. Second are the stakeholders who have two of the three key features and the least important stakeholders only have one key feature. This research focuses on the stakeholders that have all three key features. The organization is the centre point in this case. The different stakeholders will be compared to that. This leads to the employees and the customers as additional perspectives. The explanations of the relationship to the organization with regards to power, legitimacy and urgency can be found in Table 2.

Table 2: Key features of the most important stakeholders.

	Employee	Customer
Power	When the employees are not satisfied with their work schedule, they can take actions against it (e.g. though a strike).	When products/services cannot be delivered in time because of a faulty work schedule, customers can go to another supplier.
Legitimacy	Organizations have to stick to the rules that apply to work schedules that are defined in a contract with an employee or in the collective labor agreement.	The customer expects certain product/service availability. When the availability is not what they expect because of a faulty work schedule, it could harm the relationship with the organization.
Urgency	When the work schedule is not available, then employees don't know when they have to work.	When products/services cannot be delivered in time because of a faulty work schedule, customers may get problems because they don't have the products/services in time.

To show that there are also stakeholders who don't have all three key features, the suppliers and stockholders are also analyzed as an example. Suppliers do have power (late delivery can result in less work and a change in the work schedule), but they don't have legitimacy or urgency in relation to the organization's work schedule. Stockholders do have urgency. This relates to the loss of profit when products cannot be delivered in time because of a faulty work schedule. There can be power when the stockholders want to change the work scheduling process, but there is no legitimacy.

That employees and customers are the most important stakeholders next to the organization can also be found in the literature on work schedules. Some research looks at work schedules from the view of the employee (e.g. Haus & Smolensky 2006; FNV Bondgenoten, 2009b; Jeffrey Hill et al., 2011), some research looks from the view of the organization (e.g. Bambra et al., 2008; Galinsky, Sakai & Wigton, 2011; Bard & Purnomo, 2005) and some research looks from the view of the customer (e.g. Zang, Vonderembse & Lim, 2003). What is best for the employee does not necessarily have to be the best for the organization, or the customer.

When there is focused on three different perspectives, research has to be done to find how to satisfy these groups. After a brainstorm session, which included Integral and the researcher, it was concluded that the intended criteria had to be divided into categories and a few possibilities of categories were formulated. With these possibilities in mind, a literature study is performed. It is comparable to the example of the previously mentioned School-Wide Evaluation Tool, which categorized 28 items into 7 categories (Horner et al., 2004). The categories in mind were adapted, supplemented and refined and the result is six categories: work-life balance, flexibility, health, legal regulations, predictability and finance. In the next six sections, different aspects, seen form different perspectives are explained.

2.2.1. Work-life balance

Employee perspective

When a scheduler does not consider the domestic and social needs of the employees, it can result in dissatisfaction towards the schedule (Silvestro & Silvestro, 2000; Saltzstein, Ting & Saltzstein 2001). Not everyone has the same preferences. In general, free weekends and evenings are preferred (Verbiest et al, 2013), but there are also some contradicting opinions. While some people would want to work overtime, others detest it (Örmeci, Salman & Yücel, 2014). This is why, although there are some general assumptions, there is no way to make a schedule that will match the lives of all employees. Still, people always try. A way to try to satisfy all employees is introducing flexible schedules. Flexibility opportunities show care and support for employees, which result in a higher organizational commitment (Ng et al., 2006). Furthermore, several types of flexibility decrease work pressure (Russel, O'Connell & McGinnity, 2009). Because schedule flexibility is highly researched and a main topic in scheduling, it is not part of this chapter, but it will have its own chapter.

2.2.2. Flexibility

Employee perspective

Flexibility in the eyes of the employees is “the ability of workers to make choices influencing when, where, and for how long they engage in work related tasks” (Jeffrey Hill et al., 2011, p. 152). There are different motives for the employees to use the flexibility offered. First, there are personal motives. The employees can manage their different roles in different lives better. They can schedule their work time around their children, doctor appointments, errands, or they can reduce travel time (Shockley & Allen, 2012). The theory of Maslow lies on the basis of this behavior. People strive for higher-order needs. 3rd in row on the pyramid of Maslow is “belongingness and love needs” (Gleitman, Reisberg & Gross, 2007). These social needs can be achieved through flexibility. Second, there are more work related motives. Employees may increase their productivity when they are in an environment where they are less distracted or where they perceive increased creativity. Although the focus in the literature is more on the personal motives, there is evidence that work related motives are a bigger motivation to use the flexibility offered (Shockley & Allen, 2012).

There are several ways to induce flexibility: in time and in place. One way of flexibility in time is flextime. With flextime, employees can choose for themselves when they start their workday and when they end it. Most of the time there are some restrictions. Employees have to make a full day, for example eight hours, and there might be a core time where everyone has to be present (Baltes et al., 1999). For example, employees can arrive between 08.00 and 10.00 and they can leave between 16.00 and 18.00. Between 10.00 and 16.00 everyone is present. Another example of flexibility in time is a compressed workweek. Here the weekly hours are divided over fewer days. For example, when a normal work week is 40 hours in five days, employees work eight hours a day. In a compressed workweek, an employee can choose to work four days with ten hours a day (Baltes et al., 1999). Other flexibility options are being able to take a longer period off, or the ability to take regular time of to, for example, care for children or an elderly relative (Jeffrey Hill et al., 2011). A third type of flexibility in time is working part-time. With this mechanism employees have the ability to work fewer hours than the traditional 40 hour workweek. Flexibility in place can be achieved by for example working from home. This can be part time home, part time in the office, or full time working at home. Another option is to change worksites between the options of the employer. When the employer has several offices on several locations, an employee can choose to work on a different location for a period of time. A way to make workplace flexibility possible is with the use of technology, for example a virtual office (Jeffrey Hill et al., 2011). All these types of flexibility can be beneficial for the social needs of the employees. But when an actual schedule has to be made because there have to be employees present at certain times, these types of flexibility are not always possible.

Another dimension of flexibility is the ability to create your own work schedule. NCSI (2009) gave five types with increasing control for the employee. The first one is shift exchanging. This method exists for a long time already and gives the opportunity to trade your shift with that of a colleague after the schedule is presented by the employee. The second type is that the employer takes into account preferences of the employee. The third one is shift picking. The employer makes the shifts that have to

be filled, but the employees can fill in their own names with the shifts they want. The fourth type is matching. Matching is a lot like shift picking, but there are no shifts in the schedule yet. There is only an occupancy rate and the employees can insert their preferences. The employer will then make a schedule, matching the occupancy rate and the preferences as good as possible. The fifth and last one is self-scheduling. The employees of a team will determine who will do which activity at what time. How they fill the schedule is completely up to them, but it has to be in between the boundaries of the organization (NCSI, 2009). Methods that increase the control of employees over their work schedules are likely to have a positive effect on health (Garde et al., 2013), job satisfaction and organizational commitment (Lyness, Gornick, Stone & Grotto 2012). However, some methods work better than others. This is also related to the environment (Garde et al., 2013). While Dutch literature shows a lot of research on it, there are not many organizations who implemented the last dimension: self-scheduling (NCSI, 2009).

There are some negative effects to work place and work time flexibility for employees. Those who make use of the flexibility get offered fewer promotions, smaller salary increases and more negative performance evaluations (Galinsky, Sakai & Wigton, 2011). Another negative effect is the disruption of an employee's personal life. While it is expected that the work-life balance can be managed better with the flexibilities offered, there is also some evidence that this might work adversely. Because there are no fixed times where the employees can be reached, it is assumed that they can always be reached. This might blur the line between work and home life (Galinsky, Sakai & Wigton, 2011; Shockley & Allen, 2012), which in its turn increases work pressure (Demerouti, Bakker & Bulters, 2004; Lu & Kao, 2013). With self-scheduling, a negative effect for the employees is that the work schedule is not available for a long period of time. Garde et al. (2013) found that when employees are used to knowing their work schedule months in advance, they react negatively to the shortened availability of their work schedule.

Organizational perspective

There are positive effects of the previously mentioned flexibility applications for the organization. With flextime there is more job satisfaction and satisfaction with the work schedule (Baltes et al., 1999; Golden, 2009), a higher productivity, a lower absenteeism (Baltes et al., 1999) and a higher engagement (Galinsky, Sakai & Wigton, 2011). The results from a compressed workweek are somewhat different. There was only a higher satisfaction for the job and the work schedule found (Baltes et al., 1999) and a higher engagement with fewer intentions to look for another job (Galinsky, Sakai & Wigton, 2011). When looked at the cost perspective, there is an influence of the relation with the strategy. When the flexibility is aligned with the strategy of the organization, there is a positive effect on the profitability. When flexibility is induced in an organization with a cost reduction strategy, there was a negative effect (Lee & DeVoe, 2012). Other negative effects for the organization include that there are increased needs for managerial planning, the manager may not always be able to be present and there may be implementation costs (Baltes et al., 1999). Self-scheduling has some positive effects for the organization. It has a positive effect on health (Garde et al., 2013), which automatically results in a lower absenteeism related to sickness. Further, self-scheduling is related to a higher job satisfaction and organizational commitment (Lyness et al., 2012).

There are also ways to look at flexibility from the organization's perspective. One way is to generate workforce flexibility. That way, employees can work in different functions, which makes it easier to fill gaps when there is an increase in work or when there are employees absent. Also the number of options increases when making a new work schedule (Wright & Bretthauer 2010). The use of flexible employees generates a higher performance, quality improvements, better customer service and a higher learning curve (Hopp & van Oyen, 2004). A second form of flexibility is the use of contingent workers next to the full-time employees. With these employees, organizations can fill the gaps when the demand is high and they don't have excess employees when the demand is low. These fluctuations are very common with types as "just in time" production (Jeffrey Hill et al., 2011). But these fluctuations can also be handled without contingent workers. This can be done with the use of an annual hour system. With this system employees work more hours when there is more work and less hours when there is less work. The work hours can be different every week, but must match yearly to the contract (NCSI, 2009). This system can also be applied to work that fluctuates with the seasons.

Customer perspective

When looking from the customers' perspective, an organization can be seen as flexible when they can meet the customers' demands. Zang, Vonderembse and Lim (2003) state two types of flexibility. Volume flexibility and mix flexibility. With volume flexibility, the demand is set in numbers. How many of a certain product the customer wants at a specific time. With mix flexibility, the demand is set in certain preferences that change the product. Can a product be adapted to the needs of the customer? Volume flexibility and mix flexibility influence customer satisfaction in a positive way. One of the factors influencing these two types of flexibility is labor flexibility (Zang, Vonderembse & Lim, 2003). Labor flexibility can be divided into numerical flexibility (can the number of workers be changed), workforce flexibility (how many types of tasks can the workers perform), financial flexibility (can schedules be easily adapted) and work group flexibility (how do the employees cope with the changes) (Ramasesh & Jayakumar 1991). Zang, Vonderembse and Lim (2003) found that workforce flexibility is one of the major influences on volume flexibility and mix flexibility.

2.2.3. Health

Employee perspective

To make a schedule workable for the employees, organizations can look at the effects of the schedule on employees' health. The focus can be on restricting long working hours, or when shift work is used, how to minimize the negative effects.

Several studies found that long working hours have a negative effect on health (Akerstedt, Fredlund et al., 2002; Dembe et al., 2005; Nakata, 2012; Caruso et al., 2004) and performance (Caruso et al., 2004), and increases the chance of making mistakes (Landrigan et al., 2004). In general, these studies defined long working hours as more than eight hour shifts. From this research, one can conclude that workdays of more than eight hours should be avoided.

Shift work is a term that refers to two or more teams of employees that work on different hours to extend the time of operation. This way, organizations can extend their hours beyond office hours and may even extend to 24 hours a day. In most industrialized countries, shift workers make up at least one fourth of the working population (Akerstedt, 1990). While shift work has the big advantage of getting more work done in a shorter period of time, there are also some disadvantages, especially for the employees working in the shifts that are beyond the conventional office hours. A lot of studies focus on the biological factors of the body while investigating the effects of working with shifts. Especially the circadian rhythm plays a big role (Haus & Smolensky, 2006; Akerstadt, 1990; Bamra et al., 2008; Harrington, 2001; Van Amelsfoort et al., 2004). So first, the circadian rhythm will be explained and later the effects of disrupting it.

Circadian rhythms are rhythms that last about a day. The human body has several of these rhythms, coexisting with each other. Examples are: sleeping time, frequency of eating and drinking, body temperature, secretion of hormones, volume of urination, and sensitivity to drugs. The average natural rhythm of a human is 24.2 hours. It is adaptable to rhythms between 23 and 25 hours, but not to extremes like 28 hours (Kalat, 2007). While rhythms are stable, they can be changed, for example through difference in light. Humans can adapt to an average of one hour difference a day (Akerstedt, 1990).

When this is translated to working in shifts, and especially night shifts, there will be a shift in the rhythm of the body. But not all rhythms will adapt. The body will develop an own rhythm, apart from the working rhythm and the night/day rhythm. There are different rhythms present at the same time, which are not in balance. This is called desynchronization (FNV Bondgenoten, 2009a). It is also the difference between working night shifts and a jetlag. With a jetlag, the whole rhythm is reset in another time zone (Haus & Smolensky 2006). Desynchonization does not only apply to the rhythms within the body, also to the social rhythms. For example, when an employee has children, the rhythms of the parent do not align with the rhythms of the children. This makes it even more difficult to adapt (Haus & Smolensky 2006).

The main problem of shift workers is getting enough sleep. It is difficult to get enough sleep before an early shift, because the body is not ready to sleep yet early in the evening. Also staying asleep after a late shift is difficult, because the body already wants to wake up at a certain time (Akerstedt, 1990). Other problems are digestive problems, emotional problems, stress related illnesses (Bambra et al., 2008), pregnancy problems, heart and vascular diseases (FNV Bondgenoten, 2009a) and even an increase in the change of breast cancer and colorectal cancer are reported (Haus & Smolensky 2006). Furthermore, employees on rotating shift work have a higher chance of injury on the work floor (Bambra et al., 2008).

When using rotating shifts, there are several mechanisms that could improve the circumstances. One of these mechanisms is forward rotation instead of backward rotation. It is positively related to sleep and well-being (Haus & Smolensky, 2006; Van Amelsvoort et al., 2004). This is because the natural circadian rhythm is on average longer than 24 hours, so it is easier to adapt to a longer rhythm than to a shorter one (FNV Bondgenoten, 2009a). Another mechanism is the limitation of the number of nightshifts. A way to achieve this is to rotate the shifts rapidly, maximizing the number of serried shifts to two. This

way the disruption of the circadian rhythm will be minimal and there will be fewer problems with sleep deprivation. Also should the length of the nightshift not be longer than 8 hours. The combination of a nightshift with overtime will increase the problems arising with nightshifts (FNV Bondgenoten, 2009a).

One might think of the solution to take permanent night shifts. This will decrease the constant disruptions of the circadian rhythm. But this is not recommended because of external influences on the body. The fact that light and dark influences play a large role and most of the time the social aspects of our life do not correspond with that of the nightshift, will prevent some aspects of the circadian rhythm to adapt completely. There will be a permanent desynchronization (FNV Bondgenoten, 2009a).

Another effect on health can be the use of breaks during the work time. Research agrees that breaks have a positive effect on the reduction of fatigue, which in turn improves the well being of the employees (e.g. Boucsein & Thum, 1997; Tucker, 2003; Arlinghaus et al., 2012). This can for example result in more time spent on a task without getting injured (Arlinghaus et al., 2012) or working more efficiently (Chen et al., 2010). Verbiest et al. (2013) recommend taking a minimum of the breaks that are legally obligated, because there is still a lack of evidence concerning the optimum break schedule.

Several studies found that an increasing work pressure also has an effect on work-life balance and exhaustion. But this relationship also works the other way around. When there is a negative work-life balance, this influences work pressure negatively (Demerouti, Bakker & Bulters, 2004; Lu & Kao, 2013). Because they influence each other, a downwards negative spiral can arise.

Organizational perspective

Consequences of limited health of the employees lead to disadvantages for the company. Several studies found that the performance of workers decreases in the night (Akerstedt, 1990; FNV Bondgenoten, 2009a; CIRCADIAN Netherlands, 2011). In that time more mistakes are made (Bjerner, 1955) or employees work more slowly (Browne, 1949). Also, because of the previous mentioned health problems, the absenteeism will increase (Bambra et al., 2008).

2.2.4. Legal regulations

Organizational perspective

To prevent employees from being exploited, the government has restrictions on several subjects regarding work schedules. When these restrictions are validated, there are precautions the in the form of a fine (with a maximum of €11.250 for a person and €45.000 for a corporation) or a criminal prosecution (Ministerie van Sociale Zaken en Werkgelegenheid, 2010).

The subjects relevant to this project are limits with regard to working hours, resting times, minimum break times, Sunday rest, nightshifts and consignment. The limits specified in the Dutch legislation are schematically given in Table 3. These are general limits, targeting adults over 18 and excluding sectors that have specific rules.

Table 3: Overview of the *"arbeidstijdenwet"*

		Norm
Working hours	Per shift	12 hours
	Weekly	60 hours
	Weekly per 4 weeks	Average of 55 hours
	Weekly per 16 weeks	Average of 48 hours
Resting times	Daily rest	11 hours (consecutive) (once a week: 8 hours, when necessary because of the nature of work or working conditions)
	Weekly rest	36 hours (consecutive) or 72 hours in 14 days (distributable in parts with a minimum of 32 hours)
Breaks	With > 5,5 hours work per shift	30 minutes (or 2 x 15 minutes)
	With > 10 hours work per shift	45 minutes (or 3 x 15 minutes)
	With > 5.5 hours work per shift	15 minutes (with a collective agreement)
Sunday rest	Working Sundays	No working on Sunday unless: - In accordance with the type of work and stipulated Or - Necessary because of the nature of work or working conditions - Agreed with works council (by absence, interested employees) - Individual agreement
	Free Sundays	13 (per 52 weeks) Every other number, provided that: - Individual agreement when there are less than 13 fee Sundays every year
Nightshifts ***Nightshift:*** ***> 1 hour of work between 00.00 and 06.00***	Working hours per shift	10 hours 12 hours, provided that: - Rest after 12 hour shift - 5 times every 2 weeks - Maximum of 22 every 52 weeks
	Weekly working hours	40 hours (per 16 weeks), when ≥ 16 nightshifts every 16 weeks
	Resting time after nightshift *Valid for every nightshift ending after 02.00*	14 hours (once a week: 8 hours, when necessary because of the nature of work or working conditions)

	Resting time after ≥ nightshifts	46 hours
	Maximum length series *When a minimum of one in that series is a nightshift*	7 8, when there is a collective scheme
	Maximum number *For nightshifts ending after 02.00*	- 36 nightshifts per 16 weeks - 140 nightshifts per 52 weeks - 38 hours between 00.00 and 06.00 every 2 serried weeks
Consignment	Consignment prohibitation	- 14 consignment free days every 4 weeks - 2 x 2 days every 4 weeks no consignation and no labor
	Working hours per 24 hours	13 hours
	Working hours per week in case of nightly consignment *Applies when per 16 weeks 16 times or more consignment is imposed between 00.00 and 06.00*	- Average of 40 hours (per 16 weeks) Or - Average of 45 hours (per 16 weeks), if: - 8 hours continuous rest before a new shift starts (in case of last call between 00.00 and 06.00) Or - 8 hours continuous rest in the 18 hours following 06.00 (when the last call was between 00.00 and 06.00 and was directly followed by a new shift)

Source: Ministerie van Sociale Zaken en Werkgelegenheid (2010).

2.2.5. Predictability

Regular work schedules are highly predictable. Workdays are always the same and during the day (STV Innovatie & Arbeid, 2005; FNV Bondgenoten, 2009b), for example a 9 to 5 workday. Irregular work schedules do not per se have to be less predictable. When someone is working shifts in an organization that uses repeating work schedules, the employees know beforehand when they have to work. A work schedule is predictable when appointments can be made in the long term (FNV Bondgenoten, 2009b).

Employee perspective

When predictable work schedules are used, the percentage of work stress related to work schedules can decrease considerably. Especially employees with a non-standard work schedule (e.g. shift workers) experience a decrease in stress (STV Innovatie & Arbeid, 2005). This schedule related stress may be related to the difficulties in managing a social life. FNV Bondgenoten (2009b) states that predictability is of interest to employees who want to make appointments with friends or plan activities associated with children. Also the theory of Maslow can be applied here. People strive for security, which can be achieved through a predictable work schedule (Gleitman, Reisberg & Gross, 2007). The time a schedule

has to be available is arranged in the collective labor agreement. When this is not arranged, the law provides a safety net. It states that by absence of a collective labor agreement, the schedule has to be available 28 days beforehand. When this is not possible due to circumstances, only the resting times have to be available (Arbeidstijdenwet, Artikel 4.2, 2014).

Organizational perspective

So a predictable work schedule is preferred. But what if the environment gets disrupted? Organizations work most of the time with long term schedules when planning their employees into different shifts. But when there are certain influences that make it impossible or unwise to stick to the original schedule, changes have to be made (Bard & Purnomo, 2005). The schedule has to be modified to match the real-time situation to deal with changes in demand or resources (Hur, Mabert & Bretthauer, 2004). Examples of change in resources are absenteeism or equipment failure (Bard & Purnomo, 2005). Mismatch between capacity and demand is expensive, but changing the schedule also costs money. It is important to keep the changes between the published schedule and the realized schedule to a minimum. Not only because that is cheaper, but also because there is a change in preference from 'keeping the wishes of the employees in mind', to 'how can the schedule fit the demand' (Bard & Purnomo, 2005). There has been done a lot of research to invent models that minimize the need for changes in a schedule (e.g.Clarke, 1998; Bard & Purnomo, 2005). A solution to minimize changes in a schedule is robust planning. With robust planning, the schedule is more resistant to disruptions. The disruptions are calculated to happen, before they happen. One way of robust planning is increasing the absorbing capacity of the schedule. A second way of robust planning is increasing the recovery capacity of the schedule (Jespersen-Groth et al., 2009)**.** In conclusion, it is not beneficial for the employer or for the employee that schedules change. Therefore, the less schedules have to change, the better they are.

Customer perspective

The theory of Maslow can also be applied to the customers' view of predictability. The basic safety need, security is applicable here (Gleitman, Reisberg & Gross, 2007). When, for example an elderly woman needs caring, and hires an organization to care for her at home, she might feel safer when she has a limited number of caregivers who help her in and out of her bed than when there is a new person every day. These customers might prefer a predictable schedule with few changes.

2.2.6. Finance

Organizational perspective

To make a schedule as attractive as possible from a financial perspective, there are a few things that have to be taken into account. First, the workforce allocation problem has to be resolved. What is the minimum number of employees needed to provide minimum coverage? Organizations aim to minimize customer waiting time and avoid over capacity (Adenso-Díaz, González-Torre & García, 2002). It can have big influences on the profitability, when capacity is not matched to the demand (Hur, Mabert & Bretthauer 2004). This is especially related to the service sector. When there are too many goods, they can be stocked. With employee time, this is impossible. Time is just lost when there is no work available

(Browne, 1997). Overstaffing gives extra expenses and understaffing leads to a lower quantity or quality and gives the impression that the customer needs are not important (Adenso-Díaz, González-Torre & García, 2002). So it is important to strive for a perfect match between capacity and demand to minimize costs and maximize quality. Not only should there be thought off demand when making a schedule, also when hiring employees. When there is not enough work to let all the employees work all their contract hours, organizations are still legally obligated to pay the employees their normal fee, as if they had worked all their contract hours (Burgerlijk wetboek, Artikel 7:628, 2014). A planner should pay attention that all the contract hours are worked, before giving other employees extra hours.

Second, a bit related to the previous factor, overtime should be minimized. Though there is no legal obligation in the Dutch law to pay overtime or additional payment, in a lot of collective labor agreements it is discussed and there are agreements that indicate additional payment on top of the regular hourly wages (e.g. Collectieve Arbeidsovereenkomst voor het Technisch Installatiebedrijf, 2011; Collectieve Arbeidsovereenkomst voor het Beroepsgoederenvervoer over de weg en de verhuur van mobiele kranen, 2012; HEMA CAO, 2013; Collectieve Arbeidsovereenkomst voor de Bouwnijverheid, 2013). This leads to the conclusion that in a lot of cases overtime is more expensive than regular time, so if one strives to a schedule that is financially attractive, overtime must be minimized.

Third, also not legally determined, but discussed in collective labor agreements, is additional pay with non-standard working hours. There are some individual boundaries, but in a lot of collective labor agreements, there are regulations for additional pay for working non-standard working hours (e.g. collectieve arbeidsovereenkomst voor het Technisch Installatiebedrijf, 2011; Collectieve Arbeidsovereenkomst voor het Beroepsgoederenvervoer over de weg en de verhuur van mobiele kranen, 2012; HEMA CAO, 2013; Collectieve arbeidsovereenkomst voor de Bouwnijverheid, 2013). This leads to the conclusion that in a lot of cases, scheduling non-standard working hours is more expensive than scheduling standard working hours. When possible, non-standard working hours should be avoided, or expensive employees should be avoided in these shifts.

2.3. Conclusion

A literature study is performed to find out how the guidelines to the tool must be structured and what the content should be. When making the guidelines to a tool, the characteristics a tool must have should be taken into account. A tool must be functional, reliable, usable, efficient, maintainable and portable.

When designing this research, the tool examples mentioned in section 2.1 can be combined. A part of the Practice Guidelines Development Cycle can be used to develop the criteria that are on the basis of the present guidelines. The steps that can be used are: generate evidence-based recommendation, ratify evidence-based recommendation, and formulate practice guidelines.

The structure of the Employability Skills Assessment Tool will be used to structure the guidelines of the present research. When the guidelines are formulated, they have to be adapted to the situation. This is why criteria that are relevant to the situation have to be selected. Then a weight should be given to the criteria. The aim is to weight the criteria in the basis of the guidelines. Then the scores must be determined; which scores certain results get.

As mentioned in section 2.2, the content structure will be formed after the example of the School-Wide Evaluation tool. Six different categories are formed: work-life balance, flexibility, health, legal regulations, predictability and finance. These categories will contain several criteria that can be used to evaluate a work schedule. The categories are still very broad. There have to be made a few choices regarding the information that will be used. With the help of the interviews and the possible software constraints provided by Integral, the information will be specified to be able to use it in a tool.

An addition to the combination of the tool examples mentioned in section 2.1 is that different perspectives play a role when using the guidelines. The evaluation of a work schedule will not only be viewed from the organizational perspective, but also from the employees' and the customers' perspective. This is because they are also key stakeholders regarding work schedules.

3. Methodology

3.1. Research design

As mentioned before, this research is a design oriented research. It follows the design cycle containing: first hunch, requirements, structural specifications, prototype, implementation and evaluation. The design cycle is presented in Figure 1 on page 7. The first hunch phase was already described in chapter 1. Integral commissioned this research and on that basis a research goal was formulated. The requirements phase started with the literature study and was completed with the interviews. In the structural specifications phase, a first draft of the design was made. Then prototype was made to be able to implement the design in a pilot study. Last, the pilot study was evaluated and a final proposal was drafted.

3.2. Interviews

To complete the requirements phase after the literature study, ten interviews were conducted. Five of these interviews were with scientific experts from different institutions that deal with scheduling problems on a regular basis or have done research on the matter. The scientific experts came from an employees' organization (n=1), an employers' organization (n=1), research institutes (n=2) and a consultancy bureau (n=1). This way, there was a view from the employees' side, a view from the employers' side and three general views. The scientific experts from the research institutes were doing research to the quality of work schedules around the time of the interviews. This means that they were up to date to the subject and could provide the present research with valuable and up to date information. The other three scientific experts were dealing with schedules as a part of their daily work. The interviews with the scientific experts took about one hour.

To also get a view from the work floor, five interviews were conducted with practitioners. These practitioners make, or used to make, personnel schedules for their organization. The practitioners were customers of Integral and came from different sectors: healthcare (n=1), production (n=2) and service (n=2). These interviews also took about one hour.

A few days before the interviews took place the interviewees received a brief document that contained some information about the subjects that would be discussed. This way, the interviewees had more time to think about the subjects and what they possibly could add to the interview. Prior to the interview it was asked if it was possible that the interview was recorded and that the information given in the interview was allowed to be published. When the interviews were typed, the interviewees received the output of the interviews so that they could check the output given.

The interviews with the scientific experts were conducted with an interview scheme. The scheme can be found in Appendix A. Because the interviews are held in Dutch, the interview scheme is also in Dutch. The scheme allowed the interviews to be open, to allow a different perspective from the interviewee, but at the same time the interviews were structured to make sure that all the relevant subjects would be discussed.

The interviews with the practitioners were structured the same way as the interviews with the scientific experts. The only difference is that these interviews had an adapted interview scheme. This interview scheme, also in Dutch, can be found in Appendix B.

3.3. Data analysis

The data from the interviews was analyzed qualitatively. First, the interviews were transcribed, so the data could be analyzed easier. The interviews with the scientific experts were analyzed separately from the interviews with the practitioners. That is because the interviews had a different interview scheme, which caused the interviews to have a different structure, and also generated other information.

The method that was used to analyze the transcribed interviews was open coding, as prescribed by Boeije (2005). The program Atlas.ti 7.0 is used in this process. This program allows the user to mark entries and code them. Multiple codes can be given to an entry, and text can be selected more than one time, so sentences can be used in different entries. The codes used were generally based on the findings in the literature. The categories from the literature section (work-life balance, flexibility, health, legal regulations, predictability and finance) were used to indicate what the entry was generally about. Because there could be given multiple codes to one entry, it was also indicated what the topic within the category was. When the entry contained new information that could not obviously be related to one of the categories it got a new code that was not related to any category. Next to that, there was indicated if the entry had relevance for the employees, the organization or the customer. Last, there was differentiated if the entry was adding information to the literature study, or if it gave information regarding the weight of the different subjects or how to measure the subjects.

After the coding, the program could organize the entries so they were sorted by the codes given to them. This way, an overview of all the information of the different interviews was sorted by subject, actor, or type of information, depending on the selected codes. The information was studied, to see if there was information that could complement the literature review, and to sort the categories on importance. To do that, there was examined if there were general views that dominated, or if there were contradictions. After analyzing the interviews, the requirements phase was finished.

3.4. Design

In the execution of the structural specifications phase, the results from the interviews and the literature study were combined to formulate guidelines to develop a tool. These guidelines were formulated as a list of criteria that can be used to grade work schedules.

Because not all criteria necessarily have to have the same influence on the evaluation of a work schedule, different weights had to be assigned to the criteria. A multi criteria analysis (MCA) could be used to achieve this. A multi criteria analysis is a combination of mathematically based methods to structure multiple criteria (Rozman, Pazek, Bavec, Bavec, Turk & Majkovič 2006). There are several different kinds of MCA. The extreme weight method uses a combination of criteria and perspectives to evaluate situations. The tree diagram method assigns the criteria in categories. In the present research the categories are the categories that are found in the literature and interviews. Not only different

criteria will be assigned weights, but also the categories. This way, not all the categories have to have the same effect on the overall evaluation (Reinshagen, 2007). To be able to assign weights, the data has to give sufficient knowledge. When this is not the case, it is impossible to perform a MCA (Reinshagen, 2007). With regards to this research, there was not enough data to give a clear view and assign weights. That is why this process became the responsibility of the organizations that will use the tool.

3.5. Pilot study

The implementation phase is performed through a pilot study. Hevner et al. (2004) formulated several design evaluation methods: observational, analytical, experimental, testing and descriptive. The method used in the present research was testing, specifically functional testing. The testing is executed through a pilot test, to see if the formulated guidelines to develop a tool were built in a way that they can be used. The guidelines were taken to 3 organizations and periodically schedules were evaluated. The periods differed, depending on the schedule cycle the organization was using. The organizations were selected and had to fit a few criteria. They were customers of Integral and were using the planning software “Checks” (made by Integral), and the database had to be hosted by Integral, so an employee of Integral could obtain the output that was relevant to evaluate the schedule. The organizations came from 3 different sectors: logistics, government institution and healthcare.

While going through this process, it was checked if there were things that had to be changed. This is part of the evaluation phase. The errors found could result in changes or additions to the criteria, or changes to the process. Because the goal of this research is not to create the tool, but to only formulate guidelines to develop a tool, the pilot study was done manual with the use of selecting forms and forms on which planners could give standards. These forms can be found in Appendix E. The criteria chosen were not all used to give a total grade in this pilot study. Only the criteria for which Integral could obtain the results were used. This way, the whole process was gone through, but there was no time spent on analyzing work schedules by hand to obtain the relevant output. This was due to a time limit. After the evaluation of the pilot study, final changes were made to the design to finish the final proposal of the guidelines.

4. Results from the interviews

A total of ten interviews were conducted: five interviews with scientific experts and five interviews with practitioners from several organizations. Below are the results of these interviews. First, the results from the interviews with the scientific experts will be discussed and after that, the results from the interviews with the practitioners.

4.1. Interviews with scientific experts

In the interviews with the scientific experts the first question was what they thought were important influences on a work schedule. In general the information from the literature study was confirmed, but there were also a few additions made. First, an overview of different shift schedules. In general, there can be made a distinction between a continuous and a non continuous work schedule. With a continuous work schedule, the production is seven days a week, 24 hours a day. In this production time there are a lot of possibilities, but a five shift schedule is used a lot. In this work schedule employees work two mornings, two evenings and two nights, then they have four days off. Within this work schedule, variations can be made. For example, between the mornings and the evenings, the employee has one day off and at the end of the cycle, three days. With a non continuous work schedule, the production is only during the week. Depending on the production time that is needed, a two shift schedule or a three shift schedule can be applied. With the three shift schedule, the cycle repeats every three weeks. In these weeks, employees will work one week mornings, one week evenings and one week nights. This work schedule can be forwards or backwards rotating. The two shift schedule is built the same way as the three shift schedule, but there are no night shifts, which makes the scheduling cycle only two weeks. There are also organizations that have too much production for a three shift schedule, but not enough for a five shift schedule. For these organizations, a semi continuous work schedule can be an option. In this work schedule there is an additional day of production in the weekends (mostly on Saturdays) and this is a variant on the five shift schedule. There are a lot of other work schedules, but these are the most general. In general, a forwards rotating five shift schedule is seen as the healthiest for employees and a backwards rotating three shift schedule is seen as the most stressful for employees. But not all organizations can import a five shift schedule, because of their production size.

A second addition is that there is recently more focus on the employability of the employees. In current times of an aging population, there will be a lot more elderly employees in the near future. Especially in production, where the more stressful schedules are in place. On top of that, the retirement age is going up to 67. Because of these changes, there is a higher focus on the health of the employees.

“Especially working night shifts can be a seen as a large negative influence on health.”

One way of investing in the durability of employees is making sure the work schedules are not an assault on the health of employees. Examples of doing this can be: a forwards rotating work schedule, a limitation of the number of night shifts in a row, or a limitation of the length of shifts. Another way of investing in the durability of employees is investing in the capacity of the employees. When they are

able to perform other tasks, that not require nightshifts, employees can change to a task that has a smaller implication on their health. To achieve this, more flexibility has to be built in the work schedule, so employees are able to receive training, internally or externally.

Third, there is a belief that implementing flexibility in a lot of production companies is impossible. But other views on the matter say that it is possible.

"Well, I think that there is a lot more possible than they initially suggest."

One only has to look different to the process. A possible solution can be that the work is assigned to the employees instead of employees to the work. This might not always be possible, but there could be more possible than is thought in the recent beliefs. An example can be that maintenance can be scheduled when there is a mechanic. Another example is when there are broken shifts; other tasks can be assigned to the employee to complete the time. Flexibility is more and more a factor that organizations have to take into account. The younger employees who came into the market recently, want more flexibility. It is of more and more importance. But young employees are not the only one who want flexibility. Also, older employees do. Because the younger employees move up and the older employees will grow from beneath, eventually all employees will want more flexibility. But it seems that change is a threshold for a lot of organizations to make work schedules more flexible. When people are used to something, they don't want to change it. Not even when this change is supposed to make it better for them.

Some smaller additions to the literature are the following. In the literature workforce flexibility is namely related to the organization. But also the employee can benefit from this. The work will be less monotonous. Further, the aspect of finance is not only of importance to the organization. The employee is also influenced by finance. Not in the way the organization is, but with surcharges. These surcharges play a big role in the lives of a lot of employees and will influence the decision to work for example night shifts or not. But while surcharges are positively seen by the employees, organizations rather not have them. The last addition to the literature is that working weekends can be a constraint on the private life of employees. The preference is to have the weekends off. When that is not always possible, only working one day every weekend could be a solution, but this should be avoided. As much whole weekends off as possible should be an aspiration.

After the additions were made to the literature, the scientific experts were asked which aspects were the most important. In general, the scientific experts see flexibility as an aspect that is very important to the employees. Especially the influence on their own work schedule is mentioned.

"Employees have to have the idea that they can influence their schedule. That is important."

This influence on their work schedule seems to out rate the predictability of a work schedule. When people have influence on their work schedule, they can schedule their work around plans that are made in their private life instead of the other way around. Another factor that seems important is the financial aspect, surcharges. Employees tend to "buy off" their health. This means that health is rated lower than money.

Table 4: Overview of general aspects that influence the employees' perspective, sorted by interview, held with scientific experts.

	Interview 1	Interview 2	Interview 3	Interview 4	Interview 5
Most important		- Flexibility	- Flexibility - Predictability - Finance	- Flexibility	
Second place		- Predictability		- Predictability - Finance	
Last place	- Health		- Health	- Health	

> *"These days, there are arrangements that your health is bought off. You know it is not good for your health, but you agree with it, because you make that much more money."*

Table 4 gives an overview of the general aspects that influence the perspective of employees to whether a schedule is good or not. The aspects are sorted by importance, according to the interviews.

For the organizations, the scientific experts do not have a general overall view. One expert says that finance is one of the most important aspects. Another says that it is the last step. A view that is generally accepted is that health is of more and more importance to the organization. This is due to the previously mentioned aging population and the up going retirement age. Within the health aspect, the most important factor seems to be nightshifts. These shifts have the most negative influence on the health of employees. Table 5 gives an overview of the general aspects that influence the perspective of organizations to whether a schedule is good or not. The aspects are sorted by importance, according to the interviews. The customer was not mentioned a lot. But when mentioned, the scientific experts agreed that customers want a high quality product, at a low rate, when they need it. This means that flexibility is important, no mistakes have to be made and the production costs have to be low.

Last, the scientific experts were asked how the different aspects could be measured. A few suggestions were made. Within the health aspect, the number of night shifts can be measured. This can be in different settings, different nightshifts in a row or different nightshifts in a year. The optimum is 0, but advised is not more than 2 in a row. Also early arrival can be measured. Advised is to not schedule arrival times earlier than 07.00 AM. Another factor is the forward or backward rotation of the schedule.

When looking at flexibility for the employees, there were a few suggestions to the measurement of the influence of a schedule. There can be made a distinction to individual and collective influence. With the

Table 5: Overview of general aspects that influence the organizations' perspective, sorted by interview, held with scientific experts.

	Interview 1	Interview 2	Interview 3	Interview 4	Interview 5
Most important	- Finance - Law	- Health - Finance			- Flexibility - Predictability
Second place	- Flexibility - Health	- Law			- Health
Last place					- Finance

individual influence, there are three types of influence. The first is influence on the amount of work hours. This influence takes place with the realization of the contract, so this is not of importance to this research. The second influence is the influence on the long term schedule. The third influence is the influence on the short term. Can there be made changes in the short term to fit the needs of employees? Or can employees refuse working overtime?

The financial aspect seen from the organization can be measured from the costs of a schedule. This means the total amount of salary that will be paid in that period. A specific number can be set, for example the mean of schedule costs made in the last year, corrected for inflation. When the costs are below this number, it is a good financial schedule and when the costs are above this number, it is a bad financial schedule.

4.2. Interviews with practitioners

In the interviews with the practitioners there was first asked about the scheduling process and which influences there where from the employees and the organization on that process. This was asked to get a general idea of how such a process works. In all cases the work schedule was made by a planner. However, there were differences in the degree of influence from the employees. There was one case where the employees had no influence on the work schedule beforehand. There were no possibilities to suggest which days they wanted to be off. They could only trade shifts with each other afterwards. In three of the five cases there were possibilities to suggest which days they wanted to be off. This ranged from suggesting an occasional weekend off, to fixed days off, to giving availability to work. In the last case, there was a possibility to influence the schedule in the past. But due to a reorganization (this will be explained later in this chapter) there came a new work schedule which provided next to no influence on the schedule. The influence from the organization was less clear to the schedulers. The guidelines where not strict, but were more logical. For example, it was always clear that the schedule should fit the amount of work that has to be done. Also, the law and the collective labor agreement should be obeyed. Other things that were named were: making sure that the employees worked their entire contract hours and there was not too much overtime, making sure the resting times were sufficient, making sure there was sufficient circulation so people know what to do at several working stations and related to that making sure that there is always someone on a workstation that is competent of doing the work.

Second, the practitioners were asked what they thought where important influences on a work schedule. There were a few additions made to the literature study. They corresponded mostly to the additions made in the interviews with the scientific experts. One suggestion that was made was the influence of money on the employees. Money has a lot of influence on the perception of the employees. Another suggestion is to make sure that the employees can stay effective for the organization. That means that they stay competent to do their work. One way of a schedule to take this into account is to make a flexible schedule that allows employees to follow trainings or follow colleagues to learn to work at another station. A new addition was that under capacity not only affects the organization. When there are not enough employees, the employees that are there have to work harder to get the job done. This means that the work pressure is higher.

Third, the practitioners were asked what they thought were the most important influences on a work schedule, seen from employees and organizations. When looking at the influences that are important to the employees, flexibility, and work-life balance are mentioned as important aspects. With regards to flexibility, the practitioners did not agree about the way that employees had to influence their schedule. Especially self scheduling was not positively seen by every practitioner. This may be related to their own experiences. The positive view came mostly from practitioners in organizations that already know more about the matter.

> *"Eventually self scheduling, that would be the ultimate form."*

The negative view came mostly from practitioners in organizations that know little about self scheduling and give their employees little or no influence on their schedule.

> *"Take it from me, it isn't going to work. Then a war will break out. Because someone is going to say: but you are always that day off."*

The step to complete self scheduling in the last case may be too big. When looking at the financial aspect, employees seem to be willing to "buy off" their health when receiving surcharges.

> *"People think of one thing: money."*

This means that employees rate financial compensation higher than health. Another aspect mentioned is predictability. According to several practitioners, it is important to the employees to know when they have to work. They also thought that employees do not care as much about their long term health. One of the practitioners thought that could be because they could not feel it instantly. And when they feel that their health was going down, they cannot relate it to their work schedule. Table 6 gives an overview of the general aspects that influence the perspective of employees to whether a schedule is good or not. The aspects are sorted by importance, according to the interviews.

What most practitioners saw as the most important influences for the organization were satisfaction and flexibility. Health was also mentioned. The law was not seen as a big influence, because it was easy to stay within the boundaries. What stood out was that the financial aspect was not seen as the most important, as long as the organization performed well. When this was not the case, the practitioners thought that the financial aspect would play a larger role. The organization of one of the practitioners saw that it was not performing as well as it used to. To make sure the company stayed healthy, they had a reorganization. In this reorganization, the schedule and the scheduling process changed. This is the

Table 6: Overview of general aspects that influence the employees' perspective, sorted by interview, held with practitioners.

	Interview 6	Interview 7	Interview 8	Interview 9	Interview 10
Most important	- Flexibility - Predictability	- Finance - Work-life balance	- Work-life balance - Flexibility	- Work life balance - Flexibility	- Flexibility
Second place	- Health	- Health	- Health	- Predictability	- Predictability

Table 7: Overview of general aspects that influence the organizations' perspective, sorted by interview, held with practitioners.

	Interview 6	Interview 7	Interview 8	Interview 9	Interview 10
Most important	- Satisfaction (employee)	- Finance	- Satisfaction (employee) - Flexibility	- Satisfaction (employee and customer)	- Flexibility - Satisfaction (employee and customer) - Health
Second place	- Finance	- Satisfaction (employee and customer)	- Finance	- Finance	- Predictability - Finance
Last place					- Law

organization mentioned earlier, where the employees previously had more influence on the schedule than they now have, because the organization now looks more at the financial aspect of a schedule than to the employee satisfaction. Their priorities have changed. This shows that there are different priorities for different organizations in different situations. Table 7 gives an overview of the general aspects that influence the perspective of organizations to whether a schedule is good or not. The aspects are sorted by importance, according to the interviews. The customer was also here not mentioned a lot. But when mentioned, also the practitioners agreed that customers want a high quality product, at a low rate, when they need it.

4.3. Conclusion

Overall, the information found in the literature study is confirmed. A few additions are made, as well by the scientific experts as by the practitioners. To the question what might be important for employees or organizations, the scientific experts and the practitioners did not always agree. The answers differ too much to conclude something. This makes it difficult to make a general ranking of the aspects. The question that may have to be asked is: is there a general ranking, or does the importance differ per situation? The answer of this question may be provided by one of the interviews. A practitioner stated that the organization he is working for was not performing as well as it used to, so they changed their priorities. The preferences of the employees became less important and the financial aspect became more important. An organization in that kind of situation may want to change the weights of some criteria when evaluating their work schedules.

5. Design

The original goal of this research was to formulate guidelines to a tool that can evaluate schedules. These guidelines would then be given a weight, because not all guidelines may be evenly important. But from the data, there was not enough information available to assign the weights and the information that was available, was contradicting. Also, there was an example that suggested that there may be different situations that ask for different weights. Besides that, not all criteria are of importance to all situations. When there are no nightshifts, it is not important to know if they have an impact on the health of employees. That is why the design is slightly changed.

5.1. First design

The guidelines are presented as a list of criteria. These criteria are based on the information found in the literature and the interviews. A choice had to be made regarding the extent of information that is applicable in practice to evaluate a work schedule. In consultation with Integral, the choice is made to only include criteria from which the output can be retrieved from the actual schedule. The criteria are formulated in a way that most of the needed output could be made available by Checks, the scheduling software of Integral. The criteria are also formulated to get the total amount per schedule. When relevant, the mean per employee can be calculated. To see if there is an evenly distribution among the employees, the standard deviation can be calculated to see how much spreading there is between the employees.

The criteria are divided under the categories that are presented in the literature study: work-life balance, flexibility, health, legal regulations, predictability and finance. In the category “work-life balance”, criteria are formulated that are about the general wishes of employees. When these wishes are granted, employees should in general be able to combine their work with their personal life. In the category “flexibility”, criteria are formulated regarding the influence of the employees on their work schedule and the capability of a schedule to cope with emergencies. In the “health” category, the health of the employees is taken into account. This can be physical health, but also the capability of the employees to work when they get older and may not be able to perform heavy physical work. This is why the employability of employees is categorized in “health”. In the category “legal regulations”, the criteria indicate the categories in the “arbeidstijdenwet”, the law regarding working hours. In the category “predictability”, the changes that are made to the published schedule are measured. In the last category, “finance”, are all criteria that relate to financial results. The criteria can be found in Appendix C. Because the guidelines will be used in the Netherlands, the criteria are translated in Dutch. The Dutch criteria can be found in Appendix D.

Organizations have to follow a few steps before they are able to use the criteria to evaluate their work schedules. The steps are explained below but can be summarized as:

Step 1: Select criteria
Step 2: Give standards to criteria
Step 3: Weight criteria and categories

The organizations can select criteria from the list that are relevant to them so they only get the information that they need (step 1). To let the criteria fit with the organization, a standard is drafted by the organization. This standard shows what grades the criteria should get with certain results (step 2). Also, they can assign weights from 1 to 10 to the selected criteria themselves. That way, the criteria that are the most important to their situation will have the most influence on their evaluation. Not only the separate criteria can be given a weight, also the categories can be given weights (step 3). These weights and standards only have to be given once. With these settings, all past and future schedules can be evaluated. When needed, the settings can be changed to deal with changes in the situation of the organization.

When selecting criteria, three perspectives can be taken into account: the employees' perspective, the organizational perspective and the customers' perspective. The organizations can choose to evaluate the work schedule on only one of those perspectives. Then they have to look at the list from that perspective when selecting, giving a standard and weighting the criteria. But they can also choose to look from different perspectives. Then they have to go through the steps several times, once for each perspective.

To be able to grade a schedule, some calculations have to be performed. First the grades on the separate criteria will be calculated. Therefore, the grades received on the criteria in are multiplied by the weight they are given. This is the weighted score for the criteria. This can be translated to the following equation:

$$\text{Weighted score criterion} = \text{Grade for criterion} \times \text{Weight criterion}$$

To be able to get a grade for a category, the weighted scores of the criteria in that category have to be summed up and divided by the total amount of weight that is assigned to those criteria. This can be translated to the following equation:

$$\text{Grade for category} = \frac{\text{Sum of all weighted scores criteria}}{\text{Sum of all weights assigned to criteria}}$$

When the organization wants one overall score of the work schedule, the weights that are assigned to the categories are used. The previous equations will be used again, but this time "criterion" is replaced by "category", and "category" is replaced by "work schedule". This results in the following equations:

$$\text{Weihted score category} = \text{Grade for category} \times \text{Weight category}$$

$$\text{Grade for work schedule} = \frac{\text{Sum of all weighted scores categories}}{\text{Sum of all weights assigned to categories}}$$

5.2. Results from the pilot study

To briefly test the guidelines, a pilot test is performed. In this pilot test, the researcher went through the three steps mentioned before with a planner from 3 organizations. Then the researcher evaluated several work schedules from these organizations, based on the data that came out of the three steps.

This way, large mistakes in the guidelines or procedure could be detected and adapted. First, the general results of the pilots are presented. These results appeared in all three pilot studies. Then the results that were specific to the different pilot tests are presented.

There were some findings that relate to all the pilot studies. The first one is that the planner did not make use at all of the possibility that there could be calculated a mean and a standard deviation. The researcher did indicate the possibility a few times, but it was not important. The second finding was that the planner might not have had enough information to go through the three steps in a limited amount of time and produce meaningful standards and weights. When evaluating the work schedules, some of the output was not even close to the standards (the standards were possibly too small) or the output was in between 2 standards (the standards were possibly to broad). The third finding was that the category “Work-life balance” was not chosen at all. This could either be because the shifts that mattered were always distributed evenly, so there were no changes in the outcomes, or that the specific shifts were voluntarily. Another aspect that was not used is the ability to look at schedules from a customer point of view. It does not mean that the functions that were not chosen should be removed. Other organizations could still benefit from them. The last finding, a technical finding, was that the results to a lot of criteria that were selected by the organizations were not available to get from Checks. This could either be because the function was not available in Checks, or because the organization did not make use of it. This way, a lot of criteria were not evaluated, which made the evaluations not reliable for the organizations that participated in the pilot study.

The first pilot study was in the logistics sector. When evaluating the output, it came up that criterion 16 (How many times did employees take a shift they were not competent for?) can be extended with a second criterion that focuses more on the use of equipment. This was because it came up that an employee could normally perform the task he was supposed to do, but because he had to use a different machine (for example a small truck was broken, so a larger one had to be used), the employee was not competent anymore.

The second pilot was in a government institution. The findings related to all the pilots were applicable to this pilot. However, there were no additional comments that can be derived from this pilot.

The third pilot was in a healthcare institution. In this pilot study, something came up while evaluating criterion 8 (Shift trading). A possibility came up that someone did not want to exchange shifts with a colleague, but that he wanted to take on the shift of a colleague. That is why a new criterion can be added that contents transferring a shift.

Some additions can be made to the criteria, but the procedure itself worked properly during this pilot study. The first time, the procedure will take some time from the organization. A solid research has to be done to the standards and weights the organization wants to use. A solid organizational research combined with the use of all the functions in Checks and some additions to Checks to make all the results possible to determine, can result in a usable tool.

5.3. Final design

Concluding from the results from the pilot studies, some additions have to be made to the criteria. The first addition will be made after criterion 8. Criterion 9 will focus on shift transfer and will be:

Shift transfer

a. How many times is a shift transfer requested?
b. How many times is a shift transfer approved?
c. How many times is a shift transfer disapproved?

The second addition will be made after criterion 16 and will focus on the competence of the employees regarding the materials they work with. The new criterion will be:

How many times did employees work with equipment they were not competent for?

The rules of the first design still apply. Before organizations can use the criteria, first the tree steps have to be taken (step 1: Select criteria, step 2: Give standards to criteria, and step 3: Weight criteria and categories). The equations also stay the same. The final proposal of the guidelines to a tool to evaluate work schedules is presented in figure 2.

Figure 2: The final proposal of the guidelines.

A. Work-life balance

1. How many shifts are (partly) on Saturdays (00.00 – 24.00)
2. How many shifts are (partly) on Sundays (00.00 – 24.00)
3. How many shifts are (partly) on official holidays (00.00 – 24.00)
4. How many shifts are (partly) on specific weekdays
5. How many shifts are (partly) in the evening? (18.00 – 23.00)
6. How many shifts are (partly) in the night? (23.00 – 06.00)
7. How many free weekends are there? (Saturday 00.00 – Sunday 24.00)

B. Flexibility

8. Shift trading
    a. How many times is shift trading requested?
    b. How many times is shift trading approved?
    c. How many times is shift trading disapproved?
9. Shift transfer
    a. How many times is shift transfer requested?
    b. How many times is shift transfer approved?
    c. How many times is shift transfer disapproved?

10. Preferences
    a. How many preferences are received?
    b. How many preferences are approved?
    c. How many preferences are disapproved?
11. Shift picking
    a. How many shifts were available for shift picking?
    b. How many subscriptions were there on the open shifts?
    c. How many subscriptions were approved?
    d. How many subscriptions were disapproved?
    e. How many shifts were still open at the end?
    f. How many shifts do not correspond with the employees' choices in the first round?
12. How many times is the availability of an employee exceeded?
13. How many shifts are not filled by the employees when making their own schedule?
14. Holidays
    a. How many requests were there for a day off?
    b. How many times is a request for a day off approved?
    c. How many times is a request for a day off declined?
15. How many times was overtime refused by an employee?
16. How many times was an extra work day refused by an employee?
17. How many times did employees take a shift they were not competent for?
18. How many times did employees work with equipment they were not competent for?
19. Distribution of tasks.
    a. How many tasks do employees have to perform added up?
    b. How many tasks did the employees perform added up?
20. What percentage of shifts is performed by …
    a. Regular employees
    b. Flex-workers
    c. Other employees

<u>C. Health</u>

21. How many times did an employee have 3 or more nightshifts in a row?
22. Short cycle work schedule: how many times did an employee have 3 or more night, morning or evening shifts in a row?
23. How many shifts start before 07.00?
24. How many shifts are longer than 8 hours?
25. How many shifts are empty, leading to an increase in work pressure?
26. In how many shifts were internal trainings followed?
27. In how many shifts were external trainings followed?

D. Legal regulations

28. How many times is the “arbeidstijdenwet” broken regarding working hours?
29. How many times is the “arbeidstijdenwet” broken regarding resting times?
30. How many times is the “arbeidstijdenwet” broken regarding breaks?
31. How many times is the “arbeidstijdenwet” broken regarding Sunday rest?
32. How many times is the “arbeidstijdenwet” broken regarding night shifts?
33. How many times is the “arbeidstijdenwet” broken regarding consignment?

E. Predictability

34. How many changes were there made between the published schedule and the realized schedule?
35. Last minute changes
    a. How many days beforehand was the last change made to the schedule?
    b. How many changes were made on that time?

F. Finance

36. How many changes were there made between the original schedule and the realized schedule that result in extra costs?
37. How many shifts were empty?
38. How many shifts were overcrowded?
39. How many contract hours were not completed?
40. How many hours overtime were conducted?
41. How many irregular working hours are conducted?
    a. … % surcharge
    b. … % surcharge
    c. … % surcharge
42. What are the costs of the work schedule in euros?

6. Discussion

The goal of this research was to formulate guidelines that can be used to develop a tool that will be able to evaluate work schedules. The aim was to formulate a list of criteria, which are weighted depending on their importance. These weights do not always have to be the same. It depends on the perspective one is looking from. There are three perspectives that can be used: the employee perspective, the organizational perspective and the customer perspective. The criteria listed are divided into six categories: work-life balance, flexibility, health, legal regulations, predictability and finance. These categories are formulated with the help of the literature and the interviews. The interviews were also a method to gather information about the weights of the categories and criteria. However, it turns out that the opinions about this vary. There were too many differences between the perceived importance of the categories, let alone the separate criteria. This can be contributed to the differences in strategy. Take for example non-profit and for-profit organizations. They have substantial differences in motivation (Rhoades-Catanach, 2000; O'Connor & Raber, 2001). That is why there is chosen to change the design a little.

In the final proposal, the organizations are not only responsible for the selection of the criteria and the standards that are given to customize the criteria to the organization, but also for the weights that are assigned to the categories and the criteria. In the present design organizations can use the tool to compare their own work schedules with each other. This way a negative change that sneaks into the scheduling process can be detected more easily.

A benefit from organizations that assign weights themselves is that the tool can be adapted more easily to the situation. An example of this came forth during one of the interviews with a practitioner. In the past, when an employee wanted a day off, it was almost always granted. The employees' wishes came first. But when the organization detected that they were not doing as well as they used to, they changed their tactics. The financial part became more important to be able to avoid financial problems. For this organization, employee flexibility was more important in the past, but finance was more important in the future. When they were using the tool at the time, they could have wanted to change the weights so that flexibility would get a lower weight and finance a higher weight. To be able to assign the weights, the organizations have to expand their research when arranging the tool with aspects that concern the weights of the criteria.

6.1. Limitations

The criteria focused on the Netherlands, because Integral is a Dutch organization with Dutch customers. That is why the criteria cannot blindly be used in other countries. This is due to cultural differences. The difference between countries in power distance is one example. In the Netherlands, there is a low power distance between an employee and his superior. In, for example, Latin countries, the power distance is higher (Spector, 2008). Because of this, the need to evaluate work schedules from the perspective of the employees might be not as strong in Latin countries. Not only is the focus of this research on the Netherlands, but also on the scheduling software of Integral: Checks. Although this research did not specifically focus on Checks, there might be some details that are specific for Checks,

because that scheduling software is used in the pilot studies. Also the planners that were interviewed are working with Checks, which might influence their perspective.

Because the criteria had to be able to count something, a number of subjects are missing in the presented guidelines. From the customer perspective, the flexibility and predictability are missing. The work schedule can be an influence on customers on these subjects, but these influences cannot be measured from a work schedule. Another subject that is missing is in the health category. It is of importance to the health of employees when a work schedule is forwards or backwards rotating (Knauth & Hornberger, 2003). But this cannot be counted. When implementing the guidelines, one should be aware of the missing subjects.

This research failed to assign weights to the different categories and criteria. It is possible that there is not a general perspective to the quality of a work schedule. Another explanation related to the design of this research. Ten interviews might be insufficient to get a general view. Also, the planners were considered to be a link between the management and the employees. This is because there was thought that planners would get guidelines to make a schedule from the management and preferences from the employees. This way, they would know a little bit of both. It would have been better to interview employees, or representatives of the employees (for example members of a works council) and managers as well.

While the present research tried to take into account the characteristics of the ISO 9126 quality model, there are no tests performed to see if they are sufficient. To evaluate the characteristics, the tool should be implemented for a longer period of time and evaluated.

The last limitation was that within the pilot study, not all the output that was needed could be generated by Checks. Some needed output could be extracted easily by generating a report, but other needed output could not be generated. This could either be because the function was not available in Checks, or that the organization did not make use of the function. One of the most distinctive functions was the comparison of the published and the realized work schedule. One or more of the items related to this subject was chosen in all the pilot studies. This could indicate that it is an important feature and regrettable if it is not possible to evaluate.

6.2. Recommendations

In this section, recommendations are given to several parties. First to Integral, then to organizations that plan to use the tool when it is integrated in Checks, and last, recommendations for future research are given.

When Integral wants to fabricate a tool to evaluate work schedules using the guidelines presented in this research, they will have to make some changes and additions to Checks. Otherwise Checks cannot generate all the output needed to evaluate work schedules. One of the things that came up during the pilot study is that the availability (in time) and the competences (tasks) of the employees are one and the same in Checks. When an employee is not available to work at a certain time or on a certain day, Checks registers that the same way as if an employee is not competent to perform the task. To be able

to use the criteria from this research, Integral has to split those two items so the difference can be detected. A second change is to generate an overview of tasks employees are able to do, and which of them they performed. Now it is possible to see which tasks employees have done, but they do not necessarily have to be competent for them all.

An addition in Checks can be to add salary specifications. This way, the costs of the work schedule can be calculated. Now it is only possible to add contract types, which does not result in an actual number, but can only give an approximate number. Another addition can be to be able to compare the original schedule and the realized schedule. This is the core of the category “predictability” and is seen as an important measurement, according to the interviews and the pilot study. Without this function, the category “predictability” cannot be measured. The previous changes and additions are things that came up in the pilot study. When developing a tool using the criteria from the present research, Integral had to evaluate their software to see if all the output needed to answer the criteria can be generated. If not, they have to adapt their software to fit with the needs.

The recommendations to organizations that plan to use the tool when it is integrated in Checks are the following. First, organizations have to make sure to use all the functions available in Checks. During the pilot study, a few criteria could not be answered because the organization did not use the function that could generate the needed output. This way, the tool cannot work to its full potential and the outcome will not be as reliable as it can be. Second, organizations have to perform a solid research before using the tool. Solid standards and weights have to be assigned to the criteria and categories. When this is not properly done, the outcome can be biased and may not be useful. Third, organizations can add criteria when they feel it could improve the tool regarding their situation. A good example is the work-life balance category. In some organizations they are not used to work on Friday afternoon. When they do have to work, because there is more work to be done, it may inflict with their private life. For example, an employee normally picks up the children from school, because his partner works on that afternoon. An additional criterion in that situation can be: “How many shifts are (partly) on Friday afternoon?”.

The last recommendations are for future research. The first recommendation is to validate the guidelines presented in this research. A pilot study is performed to see if there were major flaws in the design, but the guidelines were not validated. Before they are used in practice, there has to be made sure that they measure what they are supposed to measure, that there is nothing missing, and if there aren’t still some flaws in the design. To validate the guidelines, they should be implemented in a larger number of organizations for a longer period of time. The evaluation of the characteristics of the ISO 9126 quality model should be a part of the validation. Due to a time limit, it was not possible to perform the validation in this research. The second recommendation is to investigate if there is a general perspective to the importance of the different categories. One of the limitations of this research was that the interviews might not have been representative enough. It could still be that there is no general perspective, but it cannot be excluded based on the present research.

6.3. Conclusion

The present research formulated guidelines to a tool that is able to evaluate work schedules. With this tool, work schedules of different periods in time can be compared. The tool can also be used to compare intended schedules to see which one should be used. This intended tool is more extensive than the tools that are already available. The available tools focus mainly on the health of the employees. They also do not differentiate different perspectives. The present guidelines allow an evaluation from different perspectives: the employee, the organization and the customer.

The result is a list of criteria divided into six categories (work-life balance, flexibility, health, legal regulations, predictability and finance) and a guide how to use them. It is a proposal that still has to be validated before the guidelines can be integrated in a tool. Also, when Integral wants to integrate the tool into their scheduling program “Checks”, they will have to make some modifications to their software to be able to generate all the output needed.

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Appendix A: Interview scheme scientific experts

Woord vooraf

- Bedanken voor het interview
- Interview wordt opgenomen
    - Zodat het uitgetypt kan worden en geanalyseerd
- Als het uitgetypt is, wordt het opgestuurd ter goedkeuring
    - Zodra het is goedgekeurd worden de opnames verwijderd
- Wordt openbaar gemaakt, mag als bron geciteerd worden?

Algemene introductie

- Al eerder iets verteld in mail maar toch nog even een volledig verhaal
- Voor mijn masterthese ben ik bezig met het onderwerp 'dienstroosters'
- Doel these: richtlijnen voor een tool om rooster te beoordelen
    - Roosters krijgen een cijfer op verschillende aspecten
- Doel interview: naast literatuurstudie informatie verzamelen
    - Verschillende invloeden op de kwaliteit van een rooster
    - Belangrijkste invloeden

Vragen:

1. Er zijn een aantal aspecten waarop de kwaliteit van rooster beoordeeld kan worden. Welke zou u beoordeeld willen hebben? (lijst met criteria erbij pakken en afstrepen)
2. Waarom zou u deze aspecten beoordeeld willen hebben?
3. Naar overige aspecten gaan die ik gevonden heb.
    a. Zouden deze aspecten ook nuttig zijn?
    b. Waarom wel/niet
    c. Zijn deze aspecten meer of minder belangrijk?
4. Er wordt gekeken vanuit verschillende perspectieven.
    a. Wie heeft er belang bij een goed rooster?
    b. Op wie heeft een rooster invloed?
5. Even terug naar de eerste aspecten (lijst erbij pakken met subaspecten)
   Subaspecten noemen en vragen of hier nog iets toe te voegen is
    a. Meerdere soorten (van bijv. flexibiliteit)
    b. Meerdere onderdelen?
6. Per aspect: zijn er nog subaspecten die belangrijker zijn dan andere?
    a. Soort hiërarchie maken
7. Onderlinge samenhang tussen aspecten
8. Meetbaarheid aspecten, subaspecten
9. Heeft u nog toevoegingen aan dit interview, wat voor mijn onderzoek van belang kan zijn?

Bedanken voor het interview

Lijst met criteria en onderdelen

1. Werk-privé balans
    a. Medewerkers
        i. Invloed op eigen rooster (flexibiliteit)
2. Flexibiliteit
    a. Medewerkers
        i. Worktime
        ii. Workplace
        iii. Uiteindelijk → zelfroosteren
    b. Werkgevers
        i. Workforce (op meerdere plaatsen inzetbaar)
        ii. Shiftwork
        iii. Jaarurensystematiek
    c. Klanten
        i. Volume flexibility
        ii. Mix flexibility
3. Gezondheid
    a. Medewerkers
        i. Shiftwork
        ii. Effecten op gezondheid (andere invloeden dan shiftwork?)
    b. Werkgevers
        i. Niet te lange diensten ivm productiviteit en fouten
4. Wettelijke regels werktijden
    a. Organisatie
        i. boetes
    b. Wetgeving
5. Voorspelbaarheid/regelmaat
    a. Medewerkers
        i. Verschil planning en realisatie
        ii. Regelmaat rooster
    b. Organisatie
        i. Goede voorspelling maken
    c. Klant
        i. Dezelfde gezichten zien
6. Financieel
    a. Organisatie
        i. Match tussen bezetting en behoefte (overuren/onderuren)
        ii. Toeslagen

Appendix B: Interview scheme practitioners

Woord vooraf

- Bedanken voor het interview
- Interview wordt opgenomen
    - Zodat het uitgetypt kan worden en geanalyseerd
- Als het uitgetypt is, wordt het opgestuurd ter goedkeuring
    - Zodra het is goedgekeurd, worden de opnames verwijderd
- Wordt openbaar gemaakt, mag als bron geciteerd worden?

Algemene introductie

- Al eerder iets verteld in mail maar toch nog even een volledig verhaal
- Voor mijn masterthese ben ik bezig met het onderwerp 'dienstroosters'
- Doel these: richtlijnen voor een tool om rooster te beoordelen
    - Roosters krijgen een cijfer op verschillende aspecten
- Doel interview: naast literatuurstudie informatie verzamelen
    - Verschillende invloeden op de kwaliteit van een rooster
    - Belangrijkste invloeden

Vragen:

1. Hoe werkt bij u het roosterproces?
    a. Voorkeuren organisatie
    b. Voorkeuren medewerkers
2. Er zijn een aantal aspecten waarop de kwaliteit van rooster beoordeeld kan worden. Welke zou u beoordeeld willen hebben? (lijst met criteria erbij pakken en afstrepen)
3. Waarom zou u deze aspecten beoordeeld willen hebben?
4. Er wordt gekeken vanuit verschillende perspectieven.
    a. Met wie wordt er rekening gehouden bij het maken van een rooster?
    b. Wie heeft voorrang? (organisatie, medewerkers of klanten)
5. Onderlinge samenhang tussen aspecten
6. Meetbaarheid aspecten, subaspecten
7. Heeft u nog toevoegingen aan dit interview, wat voor mijn onderzoek van belang kan zijn?

Bedanken voor het interview

Lijst met criteria en onderdelen

1. Werk-privé balans
    a. Medewerkers
        i. Invloed op eigen rooster (flexibiliteit)
2. Flexibiliteit
    a. Medewerkers
        i. Worktime
        ii. Workplace
        iii. Uiteindelijk → zelfroosteren
    b. Werkgevers
        i. Workforce (op meerdere plaatsen inzetbaar)
        ii. Shiftwork
        iii. Jaarurensystematiek
    c. Klanten
        i. Volume flexibility
        ii. Mix flexibility
3. Gezondheid
    a. Medewerkers
        i. Shiftwork
        ii. Effecten op gezondheid (andere invloeden dan shiftwork?)
    b. Werkgevers
        i. Niet te lange diensten ivm productiviteit en fouten
4. Wettelijke regels werktijden
    a. Organisatie
        i. boetes
    b. Wetgeving
5. Voorspelbaarheid/regelmaat
    a. Medewerkers
        i. Verschil planning en realisatie
        ii. Regelmaat rooster
    b. Organisatie
        i. Goede voorspelling maken
    c. Klant
        i. Dezelfde gezichten zien
6. Financieel
    a. Organisatie
        i. Match tussen bezetting en behoefte (overuren/onderuren)
        ii. Toeslagen

Appendix C: First design of the guidelines (English)

A. Work-life balance

1. How many shifts are (partly) on Saturdays (00.00 – 24.00)
2. How many shifts are (partly) on Sundays (00.00 – 24.00)
3. How many shifts are (partly) on official holidays (00.00 – 24.00)
4. How many shifts are (partly) on specific weekdays
5. How many shifts are (partly) in the evening? (18.00 – 23.00)
6. How many shifts are (partly) in the night? (23.00 – 06.00)
7. How many free weekends are there? (Saturday 00.00 – Sunday 24.00)

B. Flexibility

8. Shift trading
    a. How many times is shift trading requested?
    b. How many times is shift trading approved?
    c. How many times is shift trading disapproved?
9. Preferences
    a. How many preferences are received?
    b. How many preferences are approved?
    c. How many preferences are disapproved?
10. Shift picking
    a. How many shifts were available for shift picking?
    b. How many subscriptions were there on the open shifts?
    c. How many subscriptions were approved?
    d. How many subscriptions were disapproved?
    e. How many shifts were still open at the end?
    f. How many shifts do not correspond with the employees' choices in the first round?
11. How many times is the availability of an employee exceeded?
12. How many shifts are not filled by the employees when making their own schedule?
13. Holidays
    a. How many requests were there for a day off?
    b. How many times is a request for a day off approved?
    c. How many times is a request for a day off declined?
14. How many times was overtime refused by an employee?
15. How many times was an extra work day refused by an employee?
16. How many times did employees take a shift they were not competent for?
17. Distribution of tasks.
    a. How many tasks do employees have to perform added up?
    b. How many tasks did the employees perform added up?

18. What percentage of shifts is performed by …
    a. Regular employees
    b. Flex-workers
    c. Other employees

C. Health

19. How many times did an employee have 3 or more nightshifts in a row?
20. Short cycle work schedule: how many times did an employee have 3 or more night, morning or evening shifts in a row?
21. How many shifts start before 07.00?
22. How many shifts are longer than 8 hours?
23. How many shifts are empty, leading to an increase in work pressure?
24. In how many shifts were internal trainings followed?
25. In how many shifts were external trainings followed?

D. Legal regulations

26. How many times is the “arbeidstijdenwet” broken regarding working hours?
27. How many times is the “arbeidstijdenwet” broken regarding resting times?
28. How many times is the “arbeidstijdenwet” broken regarding breaks?
29. How many times is the “arbeidstijdenwet” broken regarding Sunday rest?
30. How many times is the “arbeidstijdenwet” broken regarding night shifts?
31. How many times is the “arbeidstijdenwet” broken regarding consignment?

E. Predictability

32. How many changes were there made between the published schedule and the realized schedule?
33. Last minute changes
    a. How many days beforehand was the last change made to the schedule?
    b. How many changes were made on that time?

F. Finance

34. How many changes were there made between the published schedule and the realized schedule that result in extra costs?
35. How many shifts were empty?
36. How many shifts were overcrowded?
37. How many contract hours were not completed?
38. How many hours overtime were conducted?

39. How many irregular working hours are conducted?
    a. … % surcharge
    b. … % surcharge
    c. … % surcharge
40. What are the costs of the work schedule in euros?

Appendix D: First design of the guidelines (Dutch)

A. Werk-privé balans

1. Hoeveel diensten vallen (deels) op zaterdag? (00.00 – 24.00)
2. Hoeveel diensten vallen (deels) op zondag? (00.00 – 24.00)
3. Hoeveel diensten vallen (deels) op officiële feestdagen? (00.00 – 24.00)
4. Hoeveel diensten vallen (deels) op specifieke werkdagen?
5. Hoeveel diensten vallen (deels) in de avond? (18.00 – 23.00)
6. Hoeveel diensten vallen (deels) in de nacht? (23.00 – 06.00)
7. Hoeveel hele vrije weekenden zijn er? (zaterdag 00.00 – zondag 24.00)

B. Flexibiliteit

8. Ruilen van diensten
    a. Hoe vaak is een ruiling aangevraagd?
    b. Hoe vaak is een ruiling goedgekeurd?
    c. Hoe vaak is een ruiling afgekeurd?
9. Voorkeuren
    a. Hoeveel voorkeuren zijn er ontvangen?
    b. Hoeveel voorkeuren zijn goedgekeurd?
    c. Hoeveel voorkeuren zijn afgekeurd?
10. Intekenrooster
    a. Hoeveel diensten waren er beschikbaar om op in te schrijven?
    b. Hoeveel keer is er ingeschreven op een dienst?
    c. Hoeveel inschrijvingen zijn goedgekeurd?
    d. Hoeveel inschrijvingen zijn afgekeurd?
    e. Hoeveel diensten waren er nog open aan het einde van de ronde?
    f. Hoeveel uiteindelijke diensten komen niet overeen met de oorspronkelijke wensen uit de eerste ronde?
11. Hoe vaak is de beschikbaarheid van een werknemer overschreden?
12. Hoeveel diensten zijn niet ingevuld door de teams wanneer er sprake is van zelfroosteren?
13. Vrije dagen
    a. Hoeveel aanvragen voor een vrije dag waren er?
    b. Hoe vaak is een aanvraag voor een vrije dag goedgekeurd?
    c. Hoe vaak is een aanvraag voor een vrije dag afgekeurd?
14. Hoe vaak werd overwerk geweigerd door een werknemer?
15. Hoe vaak werd een extra werkdag geweigerd door een werknemer?
16. Hoe vaak heeft een werknemer een dienst gedraaid waar hij niet competent voor was?
17. Verdeling van taken
    a. Hoeveel taken worden de medewerkers geacht uit te voeren, opgeteld?
    b. Hoeveel taken zijn door de medewerkers uit gevoerd, opgeteld?

18. Welk percentage van de diensten zijn uitgevoerd door…
    a. Vaste medewerkers
    b. Flex medewerkers
    c. Andere medewerkers

C. Gezondheid

19. Hoe vaak heeft een medewerker 3 nachtdiensten of meer achter elkaar gedraaid?
20. Kort cyclisch werkrooster: hoe vaak heeft een medewerker 3 of meer nacht, ochtend of avond diensten achter elkaar gedraaid?
21. Hoeveel diensten zijn voor 07.00 gestart?
22. Hoeveel diensten langer dan 8 uur waren er?
23. Hoeveel diensten waren leeg, resulterend in een hogere werkdruk?
24. Tijdens hoeveel diensten zijn interne trainingen gevolgd?
25. Tijdens hoeveel diensten zijn externe trainingen gevolgd?

D. Wetgeving

26. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. arbeidstijd?
27. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. rusttijden?
28. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. pauzes?
29. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. zondagsrust?
30. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. nachtdiensten?
31. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. consignatie?

E. Voorspelbaarheid

32. Hoeveel veranderingen waren er tussen het gepubliceerde rooster en het uitgevoerde rooster?
33. Laatste veranderingen
    a. Hoeveel dagen van tevoren is er voor het laatst iets veranderd aan het rooster?
    b. Hoeveel veranderingen zijn er toen gedaan?

F. Financiën

34. Hoeveel veranderingen waren er tussen het gepubliceerde rooster en het uitgevoerde rooster die resulteerden in kosten voor de organisatie?
35. Hoeveel diensten waren leeg?
36. Hoeveel diensten waren overbezet?
37. Hoeveel contacturen zijn niet voltooid?
38. Hoeveel overuren zijn er gemaakt?
39. Hoeveel onregelmatige diensturen zijn er gemaakt?
    a. … % toeslag
    b. … % toeslag
    c. … % toeslag

40. Wat kost het rooster in euro's?

Appendix E: Documents used with the pilot study

M = Medewerkers
O = Organisatie
K = Klant
W = Weging

A. Werk-privé balans

	M	W	O	W	K	W
1. Hoeveel diensten vallen (deels) op zaterdag? (00.00 – 24.00)						
2. Hoeveel diensten vallen (deels) op zondag? (00.00 – 24.00)						
3. Hoeveel diensten vallen (deels) op officiële feestdagen? (00.00 – 24.00)						
4. Hoeveel diensten vallen (deels) op specifieke werkdagen?						
5. Hoeveel diensten vallen (deels) in de avond? (18.00 – 23.00)						
6. Hoeveel diensten vallen (deels) in de nacht? (23.00 – 06.00)						
7. Hoeveel hele vrije weekenden zijn er? (zaterdag 00.00 – zondag 24.00)						

B. Flexibiliteit

	M	W	O	W	K	W
8. Ruilen van diensten						
a. Hoe vaak is een ruiling aangevraagd?						
b. Hoe vaak is een ruiling goedgekeurd?						
c. Hoe vaak is een ruiling afgekeurd?						
9. Voorkeuren						
a. Hoeveel voorkeuren zijn er ontvangen?						
b. Hoeveel voorkeuren zijn goedgekeurd?						
c. Hoeveel voorkeuren zijn afgekeurd?						

	M	W	O	W	K	W
10. Intekenrooster						
a. Hoeveel diensten waren er beschikbaar om op in te schrijven?						
b. Hoeveel keer is er ingeschreven op een dienst?						
c. Hoeveel inschrijvingen zijn goedgekeurd?						
d. Hoeveel inschrijvingen zijn afgekeurd?						
e. Hoeveel diensten waren er nog open aan het einde van de ronde?						
f. Hoeveel uiteindelijke diensten komen niet overeen met de oorspronkelijke wensen uit de eerste ronde?						
11. Hoe vaak is de beschikbaarheid van een werknemer overschreden?						
12. Hoeveel diensten zijn niet ingevuld door de teams wanneer er sprake is van zelfroosteren?						
13. Vrije dagen						
a. Hoeveel aanvragen voor een vrije dag waren er?						
b. Hoe vaak is een aanvraag voor een vrije dag goedgekeurd?						
c. Hoe vaak is een aanvraag voor een vrije dag afgekeurd?						
14. Hoe vaak werd overwerk geweigerd door een werknemer?						
15. Hoe vaak werd een extra werkdag geweigerd door een werknemer?						
16. Hoe vaak heeft een werknemer een dienst gedraaid waar hij niet competent voor was?						
17. Verdeling van taken						
a. Hoeveel taken worden de medewerkers geacht uit te voeren, opgeteld?						
b. Hoeveel taken zijn door de medewerkers uit gevoerd, opgeteld?						
18. Welk percentage van de diensten zijn uitgevoerd door…						
a. Vaste medewerkers						
b. Flex medewerkers						

	M	W	O	W	K	W
c. Andere medewerkers						

C. Gezondheid

	M	W	O	W	K	W
19. Hoe vaak heeft een medewerker 3 nachtdiensten of meer achter elkaar gedraaid?						
20. Kort cyclisch werkrooster: hoe vaak heeft een medewerker 3 of meer nacht, ochtend of avond diensten achter elkaar gedraaid?						
21. Hoeveel diensten zijn voor 07.00 gestart?						
22. Hoeveel diensten langer dan 8 uur waren er?						
23. Hoeveel diensten waren leeg, resulterend in een hogere werkdruk?						
24. Tijdens hoeveel diensten zijn interne trainingen gevolgd?						
25. Tijdens hoeveel diensten zijn externe trainingen gevolgd?						

D. Wetgeving

	M	W	O	W	K	W
26. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. arbeidstijd?						
27. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. rusttijden?						
28. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. pauzes?						
29. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. zondagsrust?						
30. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. nachtdiensten?						
31. Hoe vaak is de arbeidstijdenwet overtreden m.b.t. consignatie?						

E. Voorspelbaarheid

	M	W	O	W	K	W
32. Hoeveel veranderingen waren er tussen het gepubliceerde rooster en het uitgevoerde rooster?						
33. Laatste veranderingen						
a. Hoeveel dagen van tevoren is er voor het laatst iets veranderd aan het rooster?						
b. Hoeveel veranderingen zijn er toen gedaan?						

F. Financiën

	M	W	O	W	K	W
34. Hoeveel veranderingen waren er tussen het gepubliceerde rooster en het uitgevoerde rooster die resulteerden in kosten voor de organisatie?						
35. Hoeveel diensten waren leeg?						
36. Hoeveel diensten waren overbezet?						
37. Hoeveel contacturen zijn niet voltooid?						
38. Hoeveel overuren zijn er gemaakt?						
39. Hoeveel onregelmatige diensturen zijn er gemaakt?						
a. … % toeslag						
b. … % toeslag						
c. … % toeslag						
40. Wat kost het rooster in euro's?						

Categorie	*Weging*		
	M	O	K
Werk-privé balans			
Flexibiliteit			
Gezondheid			
Wetgeving			
Voorspelbaarheid			
Financiën			

Criterium: _____

Definitie	*Cijfer*	*Norm*
Zeer goed	10	
Goed	8	
Acceptabel	6	
Matig	4	
Slecht	2	
Zeer slecht	0	

Criterium: _____

Definitie	*Cijfer*	*Norm*

Criterium: _____

Definitie	*Cijfer*	*Norm*
Zeer goed	10	
Goed	8	
Acceptabel	6	
Matig	4	
Slecht	2	
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Criterium: _____

Definitie	*Cijfer*	*Norm*

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Definitie	*Cijfer*	*Norm*
Zeer goed	10	
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Zeer slecht	0	

Criterium: _____

Definitie	*Cijfer*	*Norm*