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CHAPTER 4

QUALITY FACTORS OF NURSING SCHEDULES

The previous chapter described the research method designed to analyze, operationalize, and apply the concept of nursing schedule quality. This research method consists of five phases. The present chapter describes the results of the first two of these five research phases. These two research phases concern the qualitative analysis of the concept of nursing schedule quality.

The first section of the present chapter describes the results of the survey of studies on the concept of nursing schedule quality. This survey resulted in a number of nurse scheduling goals. These scheduling goals constitute the required set of candidate quality factors, as described in the previous chapter.

The second section discusses the analysis of these nurse scheduling goals on perceivability and independence. This resulted in a working set of quality factors. These first two sections deal with the results of the first research phase (i.e. the survey of literature).

The last two sections concern the results of the second research phase (i.e. the questionnaire). The third section describes the validation of the working set of quality factors. This validation is based on a questionnaire sent to a number of nurse schedulers from different health care organizations. A so-called 'qualitative factor analysis' was used to analyze the answers given by the nurse schedulers.

The last section of the present chapter draws conclusions from the results of the qualitative factor analysis of the answers on this questionnaire. These conclusions concern the validity of the working set of quality factors. This results in the final set of quality factors of nursing schedules.

4.1 CANDIDATES FOR QUALITY FACTORS

The second chapter described the results of a survey of studies on supporting nurse scheduling. This survey was based on the comparison of the approaches followed in order to support this scheduling task. The present section describes the results of another survey of the same study material. The objective of this second survey

was to find independent factors of nursing schedule quality. This survey focused on descriptions of possible quality factors of nursing schedules. These descriptions will be called ‘candidates quality factors’ of nursing schedules.

The second survey of studies on supporting nurse scheduling resulted in eight candidate quality factors of nursing schedules (Oldenkamp & Simons, 1995a; 1995b). A cognitive task analysis for nurse scheduling (Mietus, 1994) identified these eight candidates as ‘nurse scheduling goals’. Seven of these nurse scheduling goals were identified explicitly (pp. 28-30), while the eighth nurse scheduling goal, namely ‘taking into account the physiological aspects of human beings’ (p. 30) was identified implicitly. Table 4.1 indicates these eight goals of nurse scheduling. Below, each of these candidate quality factors of nursing schedules is described.

Table 4.1 THE EIGHT GOALS OF NURSE SCHEDULING

number of the goals	description of the goals
1	to distribute the quantitative staffing proportionally
2	to distribute the qualitative staffing proportionally
3	to distribute shifts among personnel proportionally
4	to distribute shifts and days off
5	honoring wishes
6	a pleasant working atmosphere on the ward
7	continuity between and over days
8	taking into account the physiological aspects of human beings

The first nurse scheduling goal — to distribute the quantitative staffing proportionally — is related to the minimum number of nurses per shift. The quantitative demands for occupation per shift are very strict and need to be followed. All approaches to supporting nurse scheduling discussed in the second chapter take this first nurse scheduling goal into account.

The second nurse scheduling goal — to distribute the qualitative staffing proportionally — is related to the different levels of expertise within the nursing staff (i.e. registered nurses, licensed practical nurses, nursing assistants). In order to provide a sufficient level of nursing care on a twenty-four hour day, seven days

a week basis, the nursing expertise must be distributed over the different shifts. Especially, the data-based approach to supporting nurse scheduling — discussed in the second chapter — stresses this second nurse scheduling goal (see Courbon & Esaki, 1992), but a large number of other studies also take this aspect of nurse scheduling into account (see Okada & Okada, 1988, p. 54).

The proportional distribution of shifts among personnel is a third nurse scheduling goal. The purpose of this goal is to give each nurse about the same number of night shifts, evening shifts and weekends off. Several studies to supporting nurse scheduling take this nurse scheduling goal into account (see Okada, 1991).

The fourth nurse scheduling goal — to distribute shifts and days off — is related to the length of the working period and the period of days off. Both periods should not be too long or too short. Especially the optimization approach to supporting nurse scheduling — discussed in the second chapter — puts much weight on this nurse scheduling goal (see Rosenbloom & Goertzen, 1987).

Another important nurse scheduling goal concerns honoring wishes. A wish is a particular shift desired or not desired by a nurse on a particular day. By means of these wishes nurses are able to influence their own schedule. Apart from the cyclic scheduling approach, all studies to supporting nurse scheduling — discussed in the second chapter — emphasize this nurse scheduling goal (see Weil et al., 1995).

Realizing a pleasant working atmosphere on the ward is also an important nurse scheduling goal. An unpleasant working atmosphere will have a negative impact on the quality of the nursing care. A few other studies pay attention to this nurse scheduling goal (see Hung, 1992).

The seventh nurse scheduling goal — the continuity between and over days — also involves the quality of the nursing care. Continuity in the nursing crew per shift is one of the conditions for providing good nursing care. Bisseling (1993) conducted research that focused on this nurse scheduling goal.

Taking into account the physiological aspects of human beings is the last nurse scheduling goal mentioned in the results of the cognitive task analysis on nurse scheduling. This goal is directly related to the welfare and health of the nursing staff. Several studies aimed towards supporting nurse scheduling stress the importance of this nurse scheduling goal (see De Vries-Griever, 1992; Chen & Yeung, 1993; De Vries-Griever et al., 1994).

4.2 ANALYSIS OF THE CANDIDATES

The previous section described the results of a survey of literature on nurse scheduling. This survey revealed eight nurse scheduling goals. The degree to which each of these scheduling goals is attained in a nursing schedule constitutes a candidate quality factor. This section describes the analysis of this set of eight candidate quality factors (i.e. the eight nurse scheduling goals) on both perceivability and independence. The objective of these analyses concerned a conversion of this set of candidate quality factors into perceivable and independent factors of nursing schedule quality (i.e. the required working set of quality factors).

4.2.1 Analysis on perceivability

A nursing schedule is a plan containing three-dimensional combinations of shifts, nurses and the days of a specific time period. This specific time period will be called the schedule period. In a nursing schedule, only the scheduled shifts within this schedule period are perceivable.

When the eight nurse scheduling goals are analyzed on perceivability, it appears that the realization of two goals cannot be perceived in a nursing schedule. These goals are ‘honoring wishes’ (nurse scheduling goal number 5) and ‘a pleasant working atmosphere on the ward’ (nurse scheduling goal number 6).

The degree in which the wishes are honored can only be determined when the original list of wishes is compared with the actual shifts in a nursing schedule. As this information is not present in a nursing schedule, the number of honored wishes is not perceivable in a nursing schedule. Therefore the perceivability analysis eliminates this fifth nurse scheduling goal.

The same kind of argument applies to realizing a pleasant working atmosphere on the ward. A nursing schedule contains no information from which the pleasantness on a ward can be deduced. Therefore, the perceivability analysis also eliminates this nurse scheduling goal.

4.2.2 Analysis on independence

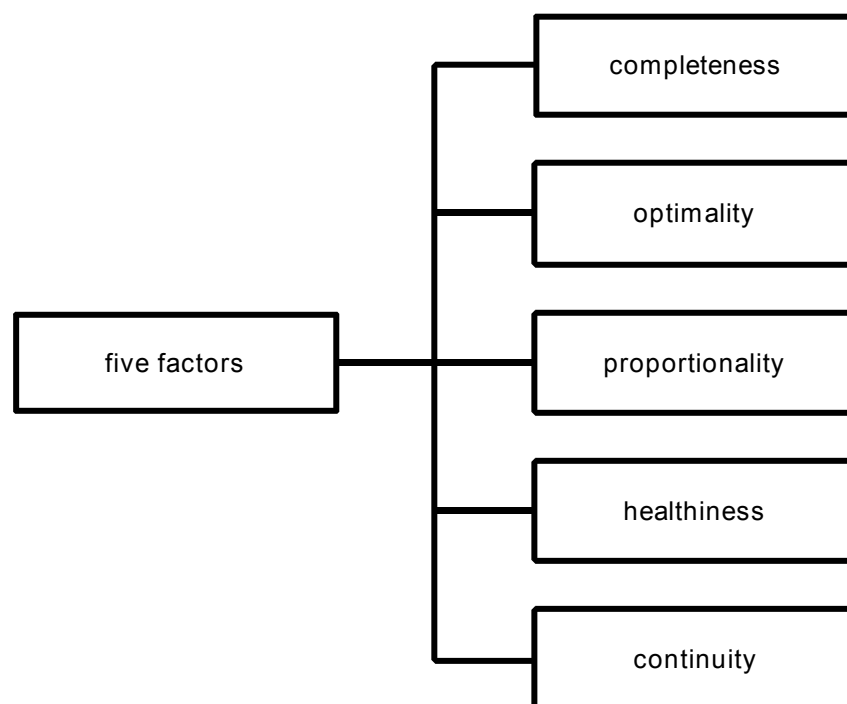
When the six remaining nurse scheduling goals are analyzed on independence, it

appears that the realization of two goals has the same impact on a nursing schedule. When shifts and days off are distributed (nurse scheduling goal number 4), the physiological aspects of human beings are indirectly also being taken into account (nurse scheduling goal number 8). Both goals can therefore be translated into one underlying quality factor. Therefore, the independence analysis reduces both nurse scheduling goals to one quality factor. This means that the six remaining scheduling goals consist of five independent quality factors. The independence of these five factors will be argued below.

4.2.3 Working set of quality factors

Submitting the eight candidate quality factors to a perceivability analysis and then to an independence analysis resulted in a working set of five perceivable and independent factors of nursing schedule quality. Figure 4.1 shows the names given to these five quality factors.

Figure 4.1 THE WORKING SET OF QUALITY FACTORS



These five quality factors are described below. These descriptions will show that these five factors differ in their focus towards the nursing schedule. These different focuses make these quality factors independent of each other (i.e. the values of a nursing schedule on each of these quality factors can be altered without changing the values of the other factors).

The completeness factor represents the degree to which the quantitative demands for occupation per shift are met. This factor concerns shortages of nurses per shift and per day of the schedule period. This means that the completeness factor is a 'vertical' factor (i.e. it 'scans' the nursing schedule from top to bottom per shift and per day).

The optimality factor represents the degree to which nursing expertise is distributed over the different shifts. This factor concerns the distribution of registered nurses (and the other types of nurses) per shift and per day of the schedule period. This means that the optimality factor is also a 'vertical' factor. However, the optimality factor focuses on the qualitative staffing demands, instead of the quantitative staffing demands, which is the focus of the completeness factor.

The proportionality factor represents the degree to which each nurse has been given about the same number of night shifts, evening shifts and weekends off. This means that the proportionality factor is a 'horizontal' factor (i.e. it 'scans' the nursing schedule from left to right per nurse).

The healthiness factor represents the degree to which care has been taken of the welfare and health of the nursing staff. This means that the healthiness factor is also a 'horizontal' factor. However, the healthiness factor focuses on the lengths of periods of days off or days on, while the proportionality factor focuses on each nurse's proportion per type of shift.

And finally, the continuity factor represents the degree to which there is continuity in the nursing staff during the different shifts. This factor focuses on the nurses who are scheduled for several consecutive shifts. This means that this continuity factor is both a horizontal and a vertical factor (i.e. it 'scans' the nursing schedule from top to bottom for nurses with consecutive (left to right) shifts).

4.3 VALIDATION OF THE QUALITY FACTORS

In order to validate the working set of five factors of schedule quality, eighteen nurse schedulers from six different health care organizations received a questionnaire. This questionnaire consisted of six parts and contained sixty-nine questions

(see Appendix A). Most questions dealt with characteristics of nurse scheduling. The analysis of the answers to these questions will be described in the following chapters. This chapter only deals with the answers given to one of these questions, namely ‘How would you define nursing schedule quality?’.

Because each nurse scheduler answered this question differently, eighteen different definitions of schedule quality were collected. The tables 4.2a and 4.2b contain the translations (into English) of these eighteen definitions of nursing schedule quality (originally given in Dutch). The numbers in front of each definition refer to the nurse scheduler who provided the given definition.

In order to analyze these eighteen definitions of schedule quality, these definitions were cut into definition phrases. A definition phrase is a part of definition which refers to one specific aspect of nursing schedules. In total, the eighteen definitions contained forty-five of these definition phrases. Based on the meaning of these phrases, a so called ‘qualitative factor analysis’ was performed. The objective of this qualitative factor analysis was a direct link between each of the forty-five phrases and one of the quality factors.

The following subsections describe the results of the qualitative factor analysis by enumerating the definition phrases per quality factor to which they refer. The numbers of each definition phrase are put in front of each phrase, while the numbers behind each phrase refer to the nurse scheduler who provided the definition which contained the given phrase.

4.3.1 Definition phrases referring to completeness

In total, seven of the forty-five phrases referred to the quality factor of completeness. These seven phrases were mentioned by seven of the eighteen nurse schedulers. Five of them explicitly referred to this feature by mentioning ‘quantity’ or ‘quantitative’. Table 4.3 shows these seven definition phrases referring to the completeness factor.

These seven defining phrases stress the quantitative staffing demands (i.e. sufficient numbers of nurses per shift). These phrases fit in very well with the given description of the completeness factor, namely the degree to which the quantitative demands for occupation per shift are met.

Table 4.2a THE EIGHTEEN DEFINITIONS OF NURSING SCHEDULE QUALITY

number	description
1	planning sufficient numbers of nurses per shift and taking into account specific shifts desired by nurses on certain days
2	providing the right numbers of nurses and levels of expertise per shift and taking into account the satisfaction of the nursing staff
3	guaranteeing both the quantitative and the qualitative staffing demands and approaching the nurses individually
4	distributing the nursing expertise equally over the shifts; taking care of healthy working schedule for each nurse (which means a maximum of eight consecutive working days); trying to schedule the types of shift desired by each nurse on specific days
5	monitoring the continuity in nursing care concerning the quantitative and the qualitative staffing demands on the basis of fixed constraints
6	arranging nursing schedules at least six weeks in advance; honoring as many as possible wishes of the nursing staff; regularity of shifts; at most eight consecutive working days; variation in day and evening shifts
7	quality of care and continuity in providing this care; quality of labor in combination with a social life and a sufficient amount of recovery time
8	a nursing schedule that guarantees in nursing care in combination with the least possible impairment of family and social life of nurses
9	a nursing schedule which provides an optimal distribution of nursing expertise over the shifts and which takes into account the impairment effects of irregular working hours

... of rest- and
 ... life of the
 ... the health
 ... at most eight consecutive working days; variation in day and evening shifts
 ... quality of recovery
 ... a nursing
 ... nurses
 ... a nursing
 ... impairment

Table 4.2b THE EIGHTEEN DEFINITIONS OF NURSING SCHEDULE QUALITY

number	description
10	taking into account both the continuity of nursing care and the types of shift desired by each nurse on specific days
11	forward shift rotation; applying labor rules concerning working hours; the right combinations of nursing expertise
12	continuity over 24 hours a day provision of nursing care in accordance with the quantitative staffing demands
13	a good distribution of both the quantity and the quality in staffing per shift, in combination with the possibility for nurses to specify desired shifts within the organizational constraints
14	well-balanced working schedules concerning the distribution of the days on and the days off and the distribution of irregular shifts (which means not a different shift on each working day and a sufficient amount of rest)
15	providing continuity in nursing care, while taking into account the personal interest of each nurse
16	continuity in the working schedules (e.g. a row of consecutive day shifts or evening shifts); making good schedule according to staff's point of view (e.g. no series of a single evening shift between day shifts and no series of consecutive days on)
17	having the right amount of nursing expertise during each day, evening and night shift
18	guaranteeing the quantitative and the qualitative staffing demands

Table 4.3 DEFINITION PHRASES REFERRING TO THE COMPLETENESS FACTOR

number	definition phrases	sched.
1	planning sufficient numbers of nurses per shift	1
3	providing the right numbers of nurses per shift	2
6	to guarantee the quantitative staffing demands	3
13	monitoring the quantitative staffing demands on the basis of fixed constraints	5
32	... in accordance with the quantitative staffing demands	12
33	a good distribution of the quantity in staffing per shift	13
44	to guarantee the quantitative staffing demands	18

sched. = scheduler

4.3.2 Definition phrases referring to optimality

Nine of the eighteen nurse schedulers mentioned optimality as a defining feature of schedule quality. Four of these nine did this explicitly by mentioning 'quality in staffing' or 'qualitative staffing demands'. Table 4.4 shows these nine definition phrases referring to the optimality factor.

These nine definition phrases stress the qualitative staffing demands (i.e. the right levels of nursing expertise per shift). These phrases fit in very well with the given description of the optimality factor, namely the degree to which nursing expertise is distributed over the different shifts.

4.3.3 Definition phrases referring to proportionality

In total, seven definition phrases referred to the proportionality factor. This was done by six of the eighteen nurse schedulers. They implicitly referred to proportionality by mentioning the distribution of the shifts or the staff's satisfaction. Table 4.5 shows these seven phrases.

Table 4.4 DEFINITION PHRASES REFERRING TO THE OPTIMALITY FACTOR

number	definition phrases	sched.
4	providing the right levels of expertise per shift	2
7	guaranteeing the qualitative staffing demands	3
9	distributing the nursing expertise equally over the shifts	4
14	monitoring the qualitative staffing demands on the basis of fixed constraints	5
24	a nursing schedule which provides an optimal distribution of nursing expertise over the shifts	9
30	the right combinations of nursing expertise	12
34	a good distribution of the quality in staffing per shift	13
43	to have the right amount of nursing expertise during each day, evening and night shift	17
45	guaranteeing the qualitative staffing demands	18

sched. = scheduler

Table 4.5 DEFINITION PHRASES REFERRING TO THE PROPORTIONALITY FACTOR

number	definition phrases	sched.
5	taking into account the satisfaction of the nursing staff	2
8	approaching the nurses individually	3
17	regularity in shifts	6
19	variation in day and evening shifts	6
36	well-balanced working schedules concerning the distribution of the days on and the days off	14
39	... while taking into account the personal interest of each nurse	15
41	no rows of a single evening shift between day shifts	16

sched. = scheduler

The last five of these seven definition phrases stress the distribution of the shifts and days off per nurse. The first two refer to this distribution indirectly: this distribution will have its effect on the satisfaction of the nursing staff (definition phrase number 5), and can best be arranged on an individual basis (definition phrase number 8). Apart from this definition phrase number eight, which stresses an individual approach, all of these phrases fit in well with the given description of the proportionality factor, which stresses a general approach, namely the degree to which each nurse has been given about the same number of night shifts, evening shifts and weekends off.

4.3.4 Definition phrases referring to healthiness

Healthiness was mentioned by eight of the eighteen nurse schedulers. In total, nine definition phrases referred to healthiness. Table 4.6 shows these nine definition phrases referring to the healthiness factor.

Table 4.6 DEFINITION PHRASES REFERRING TO THE HEALTHINESS FACTOR

number	definition phrases	sched.
10	taking care of healthy working schedules for each nurse, which means a maximum of eight consecutive working days	4
18	at most eight consecutive working days	6
21	quality of labour in combination with a social life and a sufficient amount of rest and recovery time	7
23	the least possible impairment of family and social life of the nurses	8
25	a nursing schedule which takes into account the health impairment effects of irregular working hours	9
28	forward shift rotation	11
29	applying labour rules concerning working hours	11
37	well-balanced working schedules concerning the distribution of irregular shifts, which means not a different shift on each working day and sufficient amount of rest	14
42	no series of ten consecutive days on	16

sched. = scheduler

These nine definition phrases stress the importance of sufficient rest and recovery time (i.e. healthy working schedules for each nurse). These phrases fit in very well with the given description of the healthiness factor, namely the degree to which care has been taken of the welfare and health of the nursing staff.

4.3.5 Definition phrases referring to continuity

Seven of the eighteen nurse schedulers mentioned continuity as an important feature of schedule quality. They all did this explicitly (i.e. they literally used the term 'continuity'). Table 4.7 shows the definition phrases in which these nurse schedulers referred to this continuity factor.

Table 4.7 DEFINITION PHRASES REFERRING TO THE CONTINUITY FACTOR

number	definition phrases	sched.
12	monitoring the continuity in nursing care	5
20	quality of care and continuity in providing this care	7
22	a nursing schedule that guarantees continuity in nursing care	8
26	taking into account the continuity of nursing care	10
31	continuity over 24 hours a day provision of nursing care	12
38	providing continuity in nursing care	15
40	continuity in the working schedules, e.g. a series of consecutive day shifts or evening shifts	16

sched. = scheduler

These seven definition phrases stress the importance of continuity for high-quality nursing schedules. These phrases fit in very well with the given description of the continuity factor, namely the degree to which there is continuity in the nursing staff during the different shifts.

4.3.6 Remaining phrases

The remaining six phrases concerned aspects of nurse scheduling which are not perceivable in a nursing schedule. Table 4.8 shows these definition phrases.

Table 4.8 DEFINITION PHRASES REFERRING TO IMPERCEIVABLE ASPECTS OF NURSING SCHEDULES

number	definition phrases	sched.
2	taking into account specific shifts desired by nurses on certain days	1
11	trying to schedule the types of shift desired by each nurse on specific days	4
15	arranging nursing schedules at least six weeks in advance	6
16	honouring as many wishes of the nursing staff as possible	6
27	taking into account the types of shift desired by each nurse on specific days	10
35	... in combination with the possibility for nurses to specify desired shifts within the organizational constraints	13

sched. = scheduler

Apart from defining phrase number fifteen, all these remaining definition phrases refer to the honoring of desired shifts. As discussed above, this honoring is not perceivable in an arranged nursing schedule. Defining phrase number fifteen does not refer to the nursing schedule itself. Therefore, this defining phrase is also not perceivable in a nursing schedule.

4.3.7 Conclusions of the qualitative factor analysis

The previous part of this section can be summarized as follows. The questionnaire resulted in eighteen definitions of nursing schedule quality. These definitions consisted of forty-five definition phrases. The results of a qualitative factor analysis showed that six of these forty-five definition phrases did not refer to one of the five quality factors of the working set. Furthermore, one definition phrase turned out to be

inconsistent with the description given to the corresponding quality factor. This means that more than eighty percent of the given definition phrases (i.e. 38 out of 45) referred to one of the quality factors of the working set. This validates the working set of five quality factors.

4.4 FINAL SET OF QUALITY FACTORS

The previous sections discussed the results of the first two research phases. These results consisted of a reduction of eight candidate for quality factors of nursing schedules (i.e. eight nurse scheduling goals) into a working set of five independent and perceivable quality factors. A qualitative factor analysis of the answers given to a questionnaire showed the validity of these five quality factors. Therefore, it can be concluded that the concept of nursing schedule quality can be modelled as a set of five independent and perceivable quality factors. These quality factors are called completeness, optimality, proportionality, healthiness and continuity. Figure 4.2 shows these research steps taken to find these factors of nursing schedule quality.

This provides an answer to the first research question described in the third chapter. Figure 4.3 shows the concept of nursing schedule quality consisting of five independent factors.

Figure 4.2 RESEARCH STEPS TAKEN TO FIND THE FIVE FACTORS OF NURSING SCHEDULE QUALITY

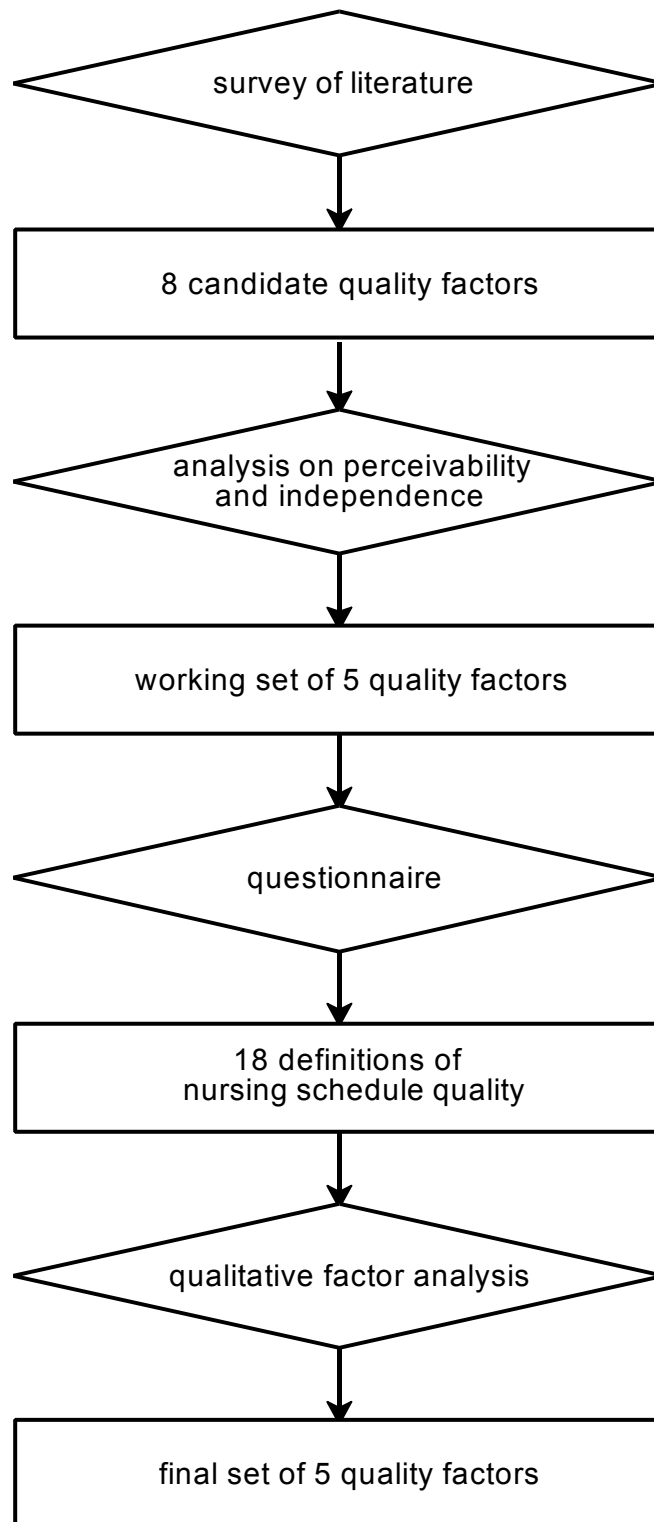


Figure 4.3 FINAL SET OF QUALITY FACTORS OF NURSING SCHEDULES

