First overview of the relationship between quantitative dynamic operational resilience and the Dutch Fire Services occupational safety & quality management program Cicero

J.M.P van Trijp
Libertas in Vivo v.o.f., Utrecht, Netherlands

A. Breur
Annemarie Breur Training & Advies, Rhoon, Netherlands

ABSTRACT:

During the course of 2011 - 2012 the Netherlands Branch Organization of Fire Services - "Brandweer Nederland" has initiated a new occupational safety and quality management program Cicero. This program is specifically designed to improve organizational design; behavior; standards and procedures of Dutch Fire Services. This paper presents a first overview of the relationship between the quantitative dynamic operational resilience and the Cicero program. It identifies overlapping and non-overlapping structures and suggests to what extend quantitative operational resilience can be used as a primary marker for assessing occupational safety and quality of a Dutch Fire Service. We found the scope of the Cicero program is much smaller than operational resilience: results show the Cicero program contributes 2.31% to the quantitative dynamic operational resilience of the organization. Suggestions are presented to enhance Cicero to a more resilience type of safety and quality management program.

1 INTRODUCTION

1.1 *Occupational safety and management program*

At the moment there are about 30,500 firefighters working for Dutch fire services. Of those about 27,000 of them are working in operational suppression and 80% are conscripted volunteers. The remaining 3,500 firefighter work in various offices like mitigation; risk control or crisis management. The large variety of service people and the complex tasks the Dutch fire services are facing today presented the opportunity to redesign the way the fire services operate. In 2010 a new doctrine was presented titled "de Brandweer over morgen" (The Fire Service tomorrow) (Brandweer Nederland, 2010a).
This doctrine presents a road map where fire services focus more on risk management and mitigation than suppression. The goal for 2040 will be all fire services use newer type of technologies, aim at a greater involvement of the resilient citizen who should be able to cope better with small and large incidents. In general the continuity of society as a whole has is a prime marker.

One of the many actions taken to accomplish this road map is the introduction of an enhanced occupational safety and quality management program: Cicero (Brandweer Nederland, 2010b). Part of this program is to develop three methodologies for quality control and assessment on strategic; tactical and operational levels combined with a complete overhaul of existing standard operating procedures (SOP) and make those SOP's available in a clearing house on the Internet.

1.2 *Operational Resilience*

Resilience in general in literature is addressed and some very usable descriptions are given by Wildawsky (1988): "To sustain normal development despite long-term stress or adversity; Rutter (1985): "Resilience is the potential (of organizations and individuals) to adapt to changing circumstances in the face of adversity and the ability to recover after a disaster or other traumatic event". Holling (1973, 1986) defined engineering resilience as " the ability of a system to return to an equilibrium or steady-state after a disturbance" or in other terms the faster a system regains stability the more resilient it is. by Holling (1996) was also the concept of ecological resilience introduce: " the magnitude of the disturbance that can be absorbed before the system changes its structure". This definition goes beyond the definitions for resilience engineering as it also implies how much disturbance a system can endure and stay

within a critical band width. Another approach to describe the functionality of an safety organization like the fire service was presented by Van Trijp *et al* (2012a, 2012b, 2013). They postulated a quantitative model describing organizational (or operational) resilience ***R***. This model consists of attributes and values describing a Unique Dynamic Operational Resilience factor $f(R_{ero})_{UV}$ of a Dutch Emergency Response Safety Region (1).

$$f(R_{ero})_{UV} = (R_{ero})_{UV}(R_{awa} + R_{kv} + R_{ac} + R_q + \varepsilon)_{UV} \quad (1)$$

where $f(R_{ero})_{UV}$ is the unique dynamic operational resilience of an emergency response safety region; UV is the utility value; R_{ero} is the level of resilience; R_{awa} is the level of awareness; R_{kv} is the level of importance of keystone vulnerabilities; R_{ac} is the level of adaptive capacity; R_q is the level of quality and ε is the level of unspecified data and items which are also a function of resilience. The quantitative result of this model is presented in arbitrary resilience units (RU) ranging from 0.00 to 22.54 where the latter is the maximum result possible.

Dutch fire services take up about 80 - 90% of Emergency Response Safety Regions and it was found that the operational resilience model was consistent with the regional fire services as well (Van Trijp *et al*, 2012a, 2012b, 2013).

2 OBJECTIVE

The main objective is 1. to identify overlapping and non-overlapping structures between the Cicero program and operational resilience and 2. to establish to what extend operational resilience $f(R_{ero})_{UV}$ can be used as a primary marker for assessing occupational safety and quality of a Dutch Fire Service.

3 CONCEPT OF CICERO

3.1 *EFQM Excellence Model*

The quality program Cicero is based on the elements of the EFQM Excellence model (Wongrassamee *et al*, 2003) and comprises out of nine blocks: 1. Leadership; 2. People Management; 3. Policy & Strategy; 4. Resources; 5. Processes; 6. People Satisfaction; 7. Customer Satisfaction; 8. Impact on Society and 9. Business Results.

In the case of Cicero the nine blocks have been partly renamed to fit the Dutch Fire Service situation: 1. Leadership; 2. Management of Co-workers; 3. Policy & Strategy; 4. Management of Resources; 5. Management of Processes; 6. Co-workers; 7. Customers & Partners; 8. Society and 9. Administration & Financiers.

These 9 blocks are interconnected and by a feedback loop (Innovation & Learning) block 9 is connected with block 1 to close the loop (figure 1). The feedback loop is introduced to enhance the performance of the organization dynamically. This model is chosen as a reference for self assessments and audits.

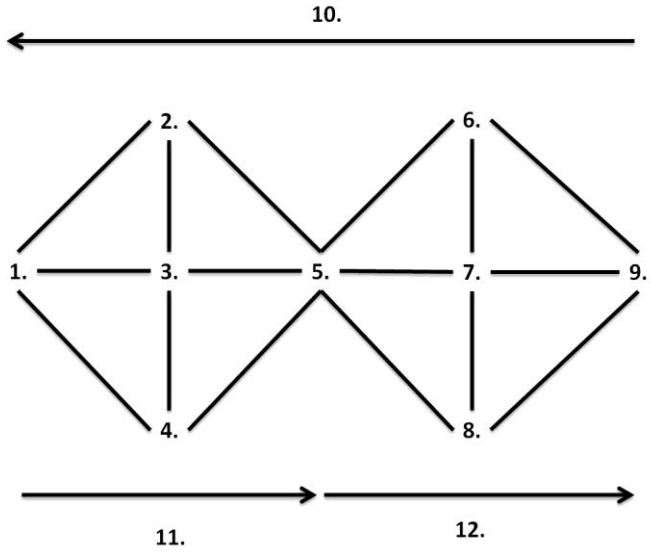

Figure 1. Cicero EFQM Excellence Cycle. 1. Leadership; 2. Management of Co-workers; 3. Policy & Strategy; 4. Management of Resources; 5. Management of Processes; 6. Co-workers; 7. Customers & Partners; 8. Society; 9. Administration & Financiers; 10. Innovation & Learning; 11. Organization and 12. Result. (Adapted from Wongrassamee, S, J.E.L. Simmons & P.D. Gardiner. 2003. Performance measurement tools: the Balanced Scorecard and the EFQM Excellence Model, *Measuring Business Excellence*; 7 (1); pp. 16).

3.2 *Auditing Model*

The EFQM Excellence model is used as a reference to develop an auditing model and instruments to assess and compare occupational safety and quality on three levels: Operational, Tactical and Strategic. Within these three levels occupational safety and quality are assessed in three different ways with different instruments. At the operational level Basic Quality Products; Processes and Services are audited by means of a self scan; an operational audit which results in an improvement plan and focuses on the day to day operations. At the tactical level the Quality of the Regional Fire Service is assessed by means of a self assessment; an organizational audit which results in a process plan and is focused on the quality and control of the Service. At the strategic level the Quality of the Regional Fire Service is assessed by means of a self assessment; an audit by peers

which results in a change plan and is focused on the Regional Fire Service as a whole. All levels are interconnected. See figure 2.

Figure 2. Cicero Auditing model with Operational, Tactical and Strategic levels. (Source: authors).

3.3 *Process Model*

The Standard Operating Procedures (SOP) which are available through the Clearing House are divided into seven levels (table 1):

Table 1. Levels of Standard Operating Procedures

Level	Description
1	Generic Process
2	Main Process
3	Sub Process
3A	Activity
4	Standard
5	Indicator
5A	Type of indicator

Each level is divided in three main clusters: Primary Processes; Supporting or Secondary Processes and Control Processes. The Primary Process are those activities which are needed or necessary to generate a product or service for a customer. These activities are the core activities of the organization. For a Regional Fire Service one may think of management of risks; disaster control and incident control. Supporting or secondary processes are supporting the core activities of the organization. One can think of communication; management information - non primary process; network management; personnel & organization; information and general facilitating services. Control Processes are all those processes that are linked to policy and control. Some examples are policy generation and control & responsibility cycles.

See figure 3.

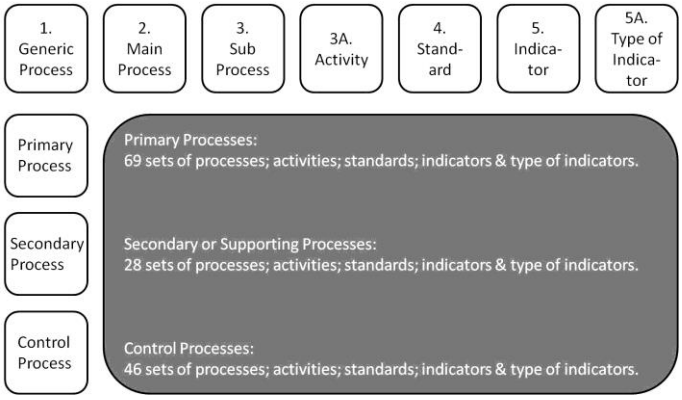

Figure 3. Cicero Process model. (Source: authors).

4 ANALYSIS

From equation (1) we identify $\boldsymbol{R_{ero}}$ the level of resilience; $\boldsymbol{R_{awa}}$ the level of awareness; $\boldsymbol{R_{kv}}$ the level of importance of keystone vulnerabilities; $\boldsymbol{R_{ac}}$ the level of adaptive capacity; $\boldsymbol{R_q}$ the level of quality and $\boldsymbol{\varepsilon}$ is the level of unspecified data and items which are also a function of resilience. All in arbitrary resilience units (RU).

$\boldsymbol{R_{ero}}$ is made up by five different attributes (***c; a; d; b; e***). $\boldsymbol{R_{awa}}$ by six attributes (***k; f; i; g; h; j***); $\boldsymbol{R_{kv}}$ by six attributes (***n; o; p; m; l; q***); $\boldsymbol{R_{ac}}$ by three attributes (***r; t; s***) & $\boldsymbol{R_q}$ by two different attributes (***w; u***) (Van Trijp *et al*, 2012a, 2012b, 2013). For explanation of the attributes, see tables 2 - 6).

We sorted the different attributes in five tables (tables 2 - 6) and scored the similarity with the Primary Processes; the Secondary or Support Processes & the Control processes

From Figure 3 it can be noticed there are 69; 28 & 46 sets of processes; activities; standards; indicators & type of indicators totalling 143 sets. $\boldsymbol{R_{ero}}$ contains 63 sets; $\boldsymbol{R_{awa}}$ contains 55 sets; $\boldsymbol{R_{kv}}$ contains 15 sets; $\boldsymbol{R_{ac}}$ contains 3 sets and $\boldsymbol{R_q}$ contains 2 sets. Results are presented in % of fit of the sets with the attributes.

Table 2. R_{ero}; % fit of the sets with the attributes

Attributes	% fit		
	Primary	Secondary	Control Processes
c	7.2	-	-
a	1.4	-	-
d	30.4	17.9	43.5
b	2.9	-	-
e	13.0	-	-

c = The potential (of organizations and individuals) to adapt to changing circumstances in the face of adversity, and the ability to recover after a disaster or other traumatic event; ***a*** = The sustenance of normal development despite long-term stress or adversity; ***d*** = The readiness of an organization before the shock or disruptive event; ***b*** = The capacity to cope with unexpected dangers after they become manifest; ***e*** = The response of the organization after the disruption has struck; - = no fit.

Table 3. R_{awa}; % fit of the sets with the attributes

Attributes	% fit		
	Primary	Secondary	Control Processes
k	10.1	25.0	8.7
f	2.9	-	-
i	-	21.4	4.3
g	2.9	-	-
h	1.1	-	23.9
j	17.4	-	2.2

k = The level of enhanced awareness of expectations, obligations and limitations in relation to the community of stakeholders, both internally (staff) and externally (customers, suppliers, consultants etc.); ***f*** = The ability to look forward for opportunities as well as potential crises; ***i*** = The level of increased awareness of the resources available both internally and externally; ***g*** = The ability to identify crises and their consequences accurately; ***h*** = The level of enhanced understanding of the trigger factors for crises; ***j*** = The level of better understand-ing of minimum operating requirements from a recovery perspective; - = no fit.

Table 4. R_{kv}; % fit of the sets with the attributes

Attributes	% fit		
	Primary	Secondary	Control Processes
n	-	-	-
o	-	-	10.9
p	2.9	7.1	-
m	-	14.3	-
l	-	7.1	-
q	-	-	-

n = The level of importance of individual managers, decision makers and subject matter experts; ***o*** = The level of relationships between key groups internally and externally; ***p*** = The level of importance of communication structures; ***m*** = The level of importance of computers, services and specialized equipment; ***l*** = The level of importance of buildings, structures and critical supplies; ***q*** = The level of perception of the organizational strategic vision; - = no fit.

Table 5. R_{ac}; % fit of the sets with the attributes

Attributes	% fit		
	Primary	Secondary	Control Processes
r	-	-	4.3
t	-	-	-
s	1.4	-	-

r = The level of importance of leadership and decision making structures; ***t*** = The degree of creativity and flexibility that the organization promotes or tolerates; ***s*** = The level of importance of the acquisition, dissemination and retention of information and knowledge; - = no fit.

Table 6. R_{q}; % fit of the sets with the attributes

Attributes	% fit		
	Primary	Secondary	Control Processes
w	-	-	-
u	1.4	3.6	4.3

w = The level of ability to adapt to changed situations with new and innovative solutions and/or the ability to adapt the tools that it already has to cope with new and unforeseen situations; ***u*** = The level of greater awareness of itself, its key-holders and the environment with which it conducts business; - = no fit.

Based on tables 2 - 6 the Cicero Quality Management program promotes primarily the attribute ***d*** (The readiness of an organization before the shock or disruptive event) with a total of 73.0% of the 63 sets of processes; activities; standards; indicators & type of indicators).

The attribute ***d*** is part of the left side (reduction + readiness) of the Bow Tie model (Ale, 2009) and is expressed in the equation for the level of resilience (2) (Van Trijp *et al*, 2012a, 2012b, 2013) as:

$$R_{ero} = (1.00c + 0.20a + 0.10d)_{Reduction + Readiness} + (0.70b + 0.30e)_{Response + Recovery} \quad (2)$$

When we equate ***c; a; b*** and ***e*** in a similar way as ***d***; we compute in arbitrary Resilience Units RU (3):

$$R_{ero} = (1.00 * 0.079 + 0.20 * 0.016 + 0.10 * 0.730) + (0.70 * 0.032 + 0.30 * 0.143) = 0.221 \text{ RU} \quad (3)$$

For the level of awareness we can compute (4); (5):

$$R_{awa} = (1.00k + 0.95f + 0.60i + 0.45g + 0.10h)_{Reduction + Readiness} + (0.10j)_{Response + Recovery} \quad (4)$$

$$R_{awa} = (1.00 * 0.327 + 0.95 * 0.036 + 0.60 * 0.145 + 0.45 * 0.036 + 0.10 * 0.218) + (0.10 * 0.236) = 0.510 \text{ RU} \quad (5)$$

For the level of importance of keystone vulnerabilities we can compute (6); (7):

$$R_{kv} = (1.00n + 0.80o + 0.70p + 0.35m + 0.25l + 0.10q)_{Reduction + Readiness} \quad (6)$$

$$R_{kv} = (1.00 * 0 + 0.80 * 0.333 + 0.70 * 0.267 + 0.35 * 0.267 + 0.25 * 0.400 + 0.10 * 0) = 0.647 \text{ RU} \quad (7)$$

For the level of adaptive capacity we can compute (8); (9):

$$\boldsymbol{R_{ac}} = (1.00\boldsymbol{r} + 0.80\boldsymbol{t} + 0.10\boldsymbol{s})_{\boldsymbol{Reduction + Readiness}} \quad (8)$$

$$\boldsymbol{R_{ac}} = (1.00 * 0.667 + 0.80 * 0 + 0.10 * 0.333) = 0.700 \text{ RU} \quad (9)$$

For the level of quality we can compute (10); (11):

$$\boldsymbol{R_q} = (1.00\boldsymbol{w} + 0.50\boldsymbol{u}) \quad (10)$$

$$\boldsymbol{R_q} = (1.00 * 0 + 0.50 * 1.000) = 0.500 \text{ RU} \quad (11)$$

All the computed values are introduced in equation (1). As there are no unspecified data and items which are also a function of resilience $\boldsymbol{\varepsilon} = 0$.

As we compare quantitative dynamic operational resilience $\boldsymbol{f(R_{ero})}$ with Cicero the utility values $\boldsymbol{UV} = 1$. (12).

$$\boldsymbol{f(R_{ero})_1} = 0.221\ (0.510 + 0.647 + 0.700 + 0.500 + 0)_{\boldsymbol{1}} = 0.521 \text{ RU} \quad (12)$$

The maximum value for $\boldsymbol{f(R_{ero})}$ = 22.54 RU (Van Trijp *et al*, 2012a, 2012b, 2013).

The result from (12) is 2.31% of the maximum value indicating the Cicero program contributes only 2.31% to the dynamic organizational resilience of the Dutch Regional Fire Services.

5 DISCUSSION

The main reason for the low contribution of Cicero to the dynamic organizational resilience is due to the large amount of sets (63) that fit to attribute ***d***: The readiness of an organization before the shock or disruptive event. It seems Cicero is of prime concern of "how the organization is ready on paper". This is also supported by high fit scores (> 10%) for the following attributes:

- ***k*** (The level of enhanced awareness of expectations, obligations and limitations in relation to the community of stakeholders, both internally (staff) and externally (customers, suppliers, consultants etc.);
- ***i*** (The level of increased awareness of the resources available both internally and externally);
- ***h*** (The level of enhanced understanding of the trigger factors for crises);
- ***j*** (The level of better understanding of minimum operating requirements from a recovery perspective);
- ***m*** (The level of importance of computers, services and specialized equipment).

All these attributes are organizational static attributes as they all deal with knowing and understanding. Only attribute ***e*** (The response of the organization after the disruption has struck) is also > 10% (10.0%) and is a dynamic attribute as it describes an active organization in the midst of the crisis response.

Cicero can be enhanced to become a more resilience like type of safety and quality management program by emphasizing those attributes that are highly prominent (weight factor > 0.40) in the equations (2) - (12) i.e. (next to those already mentioned with fit scores > 10%):

- ***c*** (The potential (of organizations and individuals) to adapt to changing circumstances in the face of adversity, and the ability to recover after a disaster or other traumatic event);
- ***b*** (The capacity to cope with unexpected dangers after they become manifest);
- ***f*** (The ability to look forward for opportunities as well as potential crises);
- ***g*** (The ability to identify crises and their consequences accurately);
- ***n*** (The level of importance of individual managers, decision makers and subject matter experts);
- ***o*** (The level of relationships between key groups internally and externally);
- ***p*** (The level of importance of communication structures);
- ***r*** (The level of importance of leadership and decision making structures);
- ***t*** (The degree of creativity and flexibility that the organization promotes or tolerates);
- ***w*** (The level of ability to adapt to changed situations with new and innovative solutions and/or the ability to adapt the tools that it already has to cope with new and unforeseen situations);
- ***u*** (The level of greater awareness of itself, its key-holders and the environment with which it conducts business).

New sets of processes; activities; standards; indicators & type of indicators. on a strategic, tactical and operational level need to be developed to meet the requirements for a resilient organization. On the other hand operational resilience $\boldsymbol{f(R_{ero})_{UV}}$ can be used as a primary marker for assessing occupational safety and quality of a Dutch Fire Service with respect to the fact that the resilience scope is about 43 times wider than the Cicero program addresses.

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