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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "The evaluation and enhancement of quality, environmental protection and safety in seaports" *by* D. Tadic et al.

D. Tadic et al.

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Response to the reviewer's comment

Authors would like to thank the reviewer for constructive comments (italic), relevant suggestions and corrections. All changes are incorporated into revised manuscript and denoted in red.The revised manuscript is given as a pdf document in supplement. We remain at your disposal for any further information.

Anonymous reviewer - General comments

The manuscript presents an application of Analytic Hierarchy Process (AHP, (Saaty, 2008)) for the ranking of "business processes" in the context of harbour management. Qualitative expert judgements are represented in terms of triangular fuzzy numbers (TFN), i.e. triples of conventional (or: crisp) numbers. Derived weights of the pairwise comparison judgements are employed for ranking priorities for the harbour management processes.
AHP has been successfully applied to various cases of multicriteria optimization problems, such as strategic and military actions, customer satisfaction, development of new products (Saaty, 2008). In this respect, I find interesting the attempt by the authors to use AHP in combination with fuzzy numbers for modeling the decisional process in a harbour. However, in order to accomplish the goal of an enhanced objectiveness and transparency, AHP should be employed using high methodological standards and with a clear analysis of the primary sources of judgment. This is actually the main criticism

I feel to move to the paper, that in fact ends up with the opposite result of making the decisional process in the harbour even more obscure and more subjective than without AHP. My concern is declined into two major issues that I have with the manuscript. Formally, it is not well organised, making it quite hard to read and verify. Concerning the contents, I find the methodology not completely sound and not capable of supporting the main conclusions. I will address both issues in detail in the specific and technical comments below.
I think that in order the manuscript to match the minimum requirements for publication in a peer reviewed journal, the authors should first analytically address all issues listed in the following.

Anonymous reviewer: A- Formal structure

A1 - Acronyms.

Several acronyms are used without any previous definition, such as: QMS, TQM, FAHP (given 13 lines after its first use in terms of AHP), AHP (that, apart from a reference within the abstract to "modified fuzzy extended analytic hierarchy process" or MFAHP, is nowhere directly defined), TFN (given just in the abstract, where it is not used, but not in rest of the paper), APQC.

Response:

- A Quality Management System (QMS) conforming to ISO 9001:2008 should be considered as an important additional step, in terms of quality, because ISO 9001 also takes into account economic and financial aspects, design and development aspects, and introduces a management review for measurement and analysis

of a process with the aim of improving performances (Poli et al., 2012). However, this important issue forces every organization to start either with ISO 9000 or Total Quality Management (TQM) as a business strategy (Sedani and Lakhe, 2011).
The number and type of business processes in a seaport is defined with respect to American Productivity and Quality Center (APQC) Process Classification Framework (PCF) and process owner opinion.
The mentioned integration includes: a) presentation of a seaport as a network of unrelated business processes so the overall success of the business processes may be assessed on the level of predefined criteria; b) the assessment of business processes by fuzzy Analytic Hierarchy Process (FAHP); c) definition of management initiatives which should lead to the improvement of business success; the order of taking management initiatives is based on the obtained rank of business processes.
Experts and operational managers use the pre-defined linguistic expressions, which are modelled by triangular fuzzy numbers (TFNs).

A2 - Organization.

The review of literature is spread among different sections and this is not justified by the reference to it done in the rest of the contents. Literature reports appear not just in the introduction (Sect.1) but also in the initial part of Sect.2 called "Materials and methods" and in whole Sect.3. The material in Sect.3 could be introduced before Sect.2.1. The main algorithm is kind of repeated in two versions: one on P4-5 and the other on P6-7. Sect.3 contains a description of KPIs that would deserve an indentation. Furthermore, no reference to the application done later on, matrices at P12-15, is done, where instead a)-e) letters are employed for sorting the various KPIs. I suggest to use the same letters in the list of KPI in Sect.3.

Response:

- References:
  David, F.: Strategic Management, Upper Saddle River, N.J. USA: Prentice Hall-Pearson, 2011.
  Hutchins, D.: Hoshin Kanri: The Strategic Approach to Continous Improvement. England: Gower e-Book, 2008.
  have been removed from the manuscript.
  Text:
  "The seaport operations may be described with a lot of uncertainties, so lately there have been many papers in literature that deal with risk management models (John et al., 2014) and metrics, proposed and numerically implemented to assess the overall performance of large systems, during natural disasters and their recovery – resilience (Shafieezadeh and Burden, 2014). This is due to the fact that much of the available data associated with port operations require a flexible but robust approach of handling as well as updating existing information with new data. As risk management activities are oriented to safety, port safety evaluation (Pak et al., 2015) is the first step in overall safety enhancement. After quality management certification, determining of performances of business processes is based on pre-defined critical success factors (CSFs) (Oakland, 2004)."
  has been moved to the section 1 in the revised manuscript.

  Section 2 of the revised manuscript has been renamed to 2 Analysis of performances, key performances indicators and business processes in a seaport.

  Section 2.1 has been renamed to 3. The model for evaluation of seaport business processes in the revised manuscript. Also, this section has been improved in a manner that the proposed algorhytm is not repeated as it has been

  suggested.

  As the reviewer suggested, in order to make the reference with the application, the identified key performance indicators have been denoted as it is presented.

  (Q1) Quality of the seaport services
  (Q2) Average number of customers
  (Q3) Average number of vessels in the queue
  (Q4) Pilotage operation of the vessel
  (E1) Quality of air
  (E2) Water quality and (E3) Noise
  (E4) Hazardous substances
  (S1) Vessel safety
  (S2) Traffic volume
  (S3) Weather sea condition and channel condition
  (S4) Other safety factors

A3 - Notation.

- *Sect.2.2 is highly repetitive and does not help in reading and memorising key quantities. I suggest to replace the contents of Sect.2.2 with a table as Tab. 1 of this review and to simplify the symbol for the fuzzy numbers: do not use x or y and just give the triple of crisp numbers making the TFN. E.g.* $(x; 2, 3, 4) \rightarrow (2, 3, 4)$.
- *Most of these symbols introduced on Sect.2.1 (e.g.* $\varepsilon, \kappa, \varphi_k, \iota, E, K, J_k, I$*) are not at all or just poorly used in the following of the manuscript.*

- *there is a confusing nomenclature about "weights vector of performance", "weights vector of KPI", and "preference vector of business process".*
- *Since I do not see any reason for breaking the alphabetical order, I would replace χ with γ in Eq.2,3 at P6.*

Table 1 *Suggested table to replace material in Sect.2.2. Please consider note on "business processes" expression in A4 item.*

	set symbol	running index	set size symbol	set size
experts	ε	e	E	4?
performances	κ	k	K	3
KPI of the kth performance	φ_k	j	J_k	4
"business processes"	ι	i	I	5

Response:

- The notation has been formatted into table.
  Table 2 notation

	running index	set size symbol	set size
heightexperts	e	E	4
heightperformances	k	K	3
heightKPI of the kth performance	j	J_k	4
heightbusiness process	i	I	5
height			

- The structure (x; 2; 3; 4) has been transformed into (2; 3; 4).

  very low importance/preferency: VL=(1,1,2)
  low importance/preferency: L=(1,2,3)

  moderate importance/preferency: M=(2,3,4)
  high importance/preferency: H=(3,4,5)
  very high importance/preferency: VH=(4,5,5)

- All unnecessary symbols have been removed in the revised manuscript.
- The alphabetical order is respected in revised manuscript.

A4 - Other.

- *do not use the word "business" both in the collective expression "business process" and for one of its actual implementations (p = 5: "business activities in seaport")! This is a highly confusing linguistic choice made by the authors, I really cannot approve it.*
- *write matrices at P11-15 as equations whose l.h.s. is some meaningful combination of symbols with pedices or apices related to the actual contents of the matrix (consider symbols introduced in Tab. 1 of this review)*
- *Fig.1 is quite complex and not entirely related to the text. It could be simplified, highlighting (i.e., numbering) the steps of the proposed methodology;*
- *caption of Fig.2 could explain more directly that the horizontal axis contains the performances, detailed per KPI. Also, the notation $^1, 2^1$, ... is quite confusing at first sight.*
- *Sentence at the end of P4 ("Value 1, and value 0 denote that one performance or KPI is as important, or unimportant, as any identified performances or KPIs under each treated performance") does not add any understanding and can be removed.*

Response:

- Adjective business has been used with processes. Sub process Business activities in seaport (p=5) has been changed into Activities in seaport (p=5).
- Matrices P11-P14 have been modified in compliance with reviewer's suggestion.
- Figure 1 has been simplified in revised manuscript.

Fig. 1. The evaluation procedure of seaport business processes by FAHP
(Please see the Fig. 1 below)

- Figure 2 has been improved in the terms of notation for better understanding in the revised manuscript.

Fig. 2. Sensitivity of each business process with respect to the KPIs
(Please see the Fig. 2 below)

- The sentence has been removed.

A5 - Figures and tables.

The list of processes in the legend of both Fig.1 and 2 is referenced both in Tab.1,2,3 and in the manuscript. Thus, it deserves an independent presentation in a specific table.

Response:

The table of processes has been incorporated into revised manuscript.

Table 1 Identified processes in the seaport

Running index	Title of the business process
heightp=1	Planning and service monitoring
heightp=2	Technology management of service providing
heightp=3	Maintenance of infrastructure
heightp=4	Management of Environmental Health and Safety
heightp=5	Activities in seaport

A6 - English.

Specific sentences are really badly formulated. E.g. "In the course of easier understanding of the proposed Algorithm, in this Section the notation is given" (P5, row14). Revision by a professional translator of technical manuscripts is highly recommended.

Response:

English has been improved.

Anonymous Reviewer: B - Actual Contents

B1 - Abstract.

The proposed model is far from being "verified", demonstrated or validated within this paper. Instead a simple numerical evaluation of the "proposed algorithm" is carried out. Furthermore, the conclusions are quite surprising, see item B5.

Response:

- The term verified is replaced in the revised manuscript.
- model is tested through an illustrative example with real life data, where the obtained data suggest measures which should enhance business strategy and improve key performance indicators.

B2 - Problem statement and methodology.

- *First of all, see all comments done in A, since the actual scientific contents of a paper can be hardly detached from their presentation style.*
- *It should be more clearly stated what the input data for all subsequent elaborations are. In particular, the weights $w_e = (.4, .3, .2, .1)$ of the experts used are present in the example of line 14 of P10. I -and I think most readers too- would like to see a table where these weights are clearly associated to the 4 experts (not sure if in this order, but they seem to be: seaport owner, main manager, local government, operational management of the seaport).*
- *Furthermore, the most influential expert overweights by 4 times the least influential one. How were the w_e assessed? This raises the more fundamental question "who is judging the judges?". This information about expert judgement is quite crucial for the actual numerical outcomes, see B5.*
- *as from the definitions of the base TFNs (P4), the authors use a linear scale $[1/\sigma, \sigma]$ with $\sigma = 5$. The type of scale (Ishizaka and Labib, 2009) and the quantity σ are keys in a pairwise comparison matrix, representing the accuracy of the judgements and indirectly affecting matrix consistency, see e.g. (Ramík, 2009). It is usually taken $\sigma = 9$ (Saaty, 2008). In my opinion, the actual choice of the quality and extent of the scale deserves a dedicated comment by the authors.*

- *why are there so many crisp numbers (1,1,1) in the off-diagonal elements of the pairwise comparison matrixes at P11-15 ? The authors make a big point about modeling uncertainty in terms of fuzzy numbers, and then it turns out that several specific processes can be assessed to have exactly the same relative importance (such is in fact the meaning of (1,1,1) in the matrixes). I find it odd that there is not even a comment on this.*

Response:

- All comments defined in the part A have been incorporated into revised manuscript.
- Based on the internal policy of treated seaport, the expert team is adjoined with different specific weights (table 3).

Table 3 - Specific weights of expert team

Experts	Specific weight of the expert
heightseaport owner	0.4
heightmain manager	0.3
heightlocal government expert	0.2
heightThe representative of operational management of the seaport	0.1

- We want to thank to the reviewer for this very useful comment. However, the proposed model is tested in one seaport in the process of restructuring in developing country. Our truthful intention was to describe the real situation so we had similar questions (like reviewer) but we have decided to stick with the real situation.

- According to Ishizaka and Labib, (2009), the verbal comparison must be converted into numerical scales, such as linear (Power, Geometric, Logarithmic, etc.). Also, mentioned authors have concluded that "Theoretically there is no reason to be restricted to these numbers and verbal gradation."In the revised manuscript, we have decided to proceed like Chang (1996). The domains of fuzzy numbers can be defined on different scales (Ishizaka and Labib, 2009) and in this paper the domains of presented TFNs are defined into interval [1-5].
  Chang, D., Y.: Applications of the extent analysis method on fuzzy AHP, European Journal of Operational Research, 95, 649-655, doi:10.1016/0377-2217(95)00300-2, 1996.

- All judgements were made by experts and authors came to the similar conclusion as a reviewer. There are some crisp numbers (1, 1, 1) in the off-diagonal elements but we wanted to present the real state and opinion of experts.

B3 - Pairwise comparison matrices.

- *The numerical case study (Sect. 4) starts all of a sudden with a pairwise comparison matrix, whose relevance to the method (which is great) is never mentioned but in Fig.1.*

- *The consistency of this matrix (Ramík, 2009) is never evaluated nor discussed. Given the qualitative nature of the expert judgements, consistency is a quite relevant concern of an AHP investigation (Saaty, 2008). Thus, I believe some measure of consistency should be computed and provided for all comparison matrixes in the manuscript. E.g. is the consistency ratio below the classical threshold of %?*

Response:

- The presence of the pairwise comparison matrix has been emphasized in the figure 1 in revised manuscript.

- Thank you for the very useful suggestion. We have calculated consistency of the matrices and expert team did the assessment again, more carefully. Improvement of the revised manuscript are following:
  Fuzzy pair-wise comparison matrices of the relative importance of performance, the relative importance of KPI under each performance and preference of business processes respecting each KPI are stated. Before all the calculation of vectors of priorities it is necessary to determine the coefficient of consistency to reflect the consistency of the decision makers' judgements during the evaluation phase (Saaty, 2008). Calculation of consistency may be delivered by using the method of logarithmic least squares (Lootsma, 1996), eigen vector method (Saaty, 2008), method of geometric mean (Ramik, 2009), etc. The eigen vector method represents a natural measure for inconsistency and it is used in wide literature and it is used in this paper, too. It is worth to mention that all relevant indexes of consistence (C.I.) should be equal or below the threshold of 0.1.
  The elements of constructed fuzzy pair-wise matrices are defuzzified, and after that, the consistence of fuzzy pair-wise matrices is determined. It is determined by analogy with Torfi et al., (2010).

Please note the pdf document given as an addition to the B3 response and attached as a separate pdf file in the compressed supplement to this comment, where the fuzzy pair-wise comparison matrices of the relative importance of performance, the relative importance of KPI under each performance and preference of business processes respecting each KPI are stated.

- Preference indices of business processes under each identified criterion are calculated by using procedure (Step 3 of the proposed Algorithm). By using the proposed procedure (Step 5 to Step 7) the rank of business processes under evaluation criteria is determined.
  The calculated preference indices of the treated business processes and their rank under the identified evaluation criteria are presented in the following text (Table 4, Table 5, Table 6).

Table 4 Preference indices of business processes and their rank under quality performance

Process no.	Preference index	Rank	Degree of belief that business process can be the best
heightp=1	(0.13,0.329,0.828)	1	1
p=2	(0.086,0.211,0.559)	3	0.784
p=3	(0.085,0.114,0.294)	4	0.432
p=4	(0.041,0.092,0.226)	5	0.288
p=5	(0.097,0.247,0.379)	2	0.752
height			

Table 5 Preference indices of business processes and their rank under environmental protection performance

Process no.	Preference index	Rank	Degree of belief that business process can be the best
heightp=1	(0.065,0.172,0.5)	3	0.715
p=2	(0.111,0.327,0.915)	1	1
p=3	(0.099,0.298,0.801)	2	0.959
p=4	(0.031,0.083,0.248)	5	0.359
p=5	(0.041,0.118,0.339)	4	0.522
height			

Table 6 Preference indices of business processes and their rank under safety performance

Process no.	Preference index	Rank	Degree of belief that business process can be the best
heightp=1	(0.087,0.166,0.447)	4	0.721
p=2	(0.106,0.298,0.68)	1	1
p=3	(0.072,0.181,0.494)	3	0.768
p=4	(0.049,0.129,0.328)	5	0.568
p=5	(0.089,0.225,0.578)	2	0.866
height			

Table 7 The overall preference index

Process no.	Preference index	Rank	Degree of belief that business process can be the best
heightp=1	(0.065,0.231,0.9)	2	0.956
p=2	(0.066,0.269,1)	1	1
p=3	(0.067,0.175,0.697)	4	0.869
p=4	(0.028,0.107,0.409)	5	0.677
p=5	(0.055,0.215,1.686)	3	0.918
height			

B4 Missing originality.

The specificity of the claimed "modified" FAHP (MFAHP) method proposed by the authors is not demonstrated nor stated. The core of the proposed algorithm (steps # 5-8 of Sect.2.1) is just a few standard rules taken from the literature, while the rest (steps # 1-4 of Sect.2.1) is just definitions. Unless the authors clearly state where the originality of the proposed algorithm is, I think they cannot claim to have developed a new method: they just made an application of an existing one, and the use of the dedicated acronym MFAHP is not justified, in my opinion.

Response:

Authors have started from the work of Chang (1996). In the literature, there is a wide range of variations of this work (like our manuscript). For example, the calculation of weights or preferences may be performed in different ways (Torfi et al., 2010).
F. Torfi, R.Z. Farahani, S. Rezapour, Fuzzy AHP to determine the relative weights of evaluation criteria and Fuzzy TOPSIS to rank the alternatives. Applied Soft Computing,

10 (2) (2010), 520-528.

We agree with the reviewer that proposed fuzzy AHP is not significantly modi- fied so term modified has been deleted in the revised manuscript.

3. The model for evaluation of seaport business processes

The proposed evaluation procedure can be realized in a way that is presented in fig. 1.

Fig. 1 The evaluation procedure of seaport business processes by AHP

(Please see the Fig. 3 below)

B5 Not fully justified conclusions.

According to Tab.1 and Tab.3 the "business activities in seaport" process (p = 5) gets rank 1 for both the quality and the safety performance. How can a business activity be the most crucial action for enhancing safety of a harbour? The authors comment this surprising finding by stating that "the level of customers' satisfaction mostly depends on quality of this business process realisation, so the obtained result is expected" (P15, rows 23-24). I actually thought that the focus of the paper was to establish priorities for the port management without a specific perspective on customers, but in view of multi-criteria optimization. If instead the authors mean that the whole analysis is just functional to enhance customers' satisfaction, then the title, abstract and scope of the paper should be consequently restricted. In any case, I cannot easily accept that business activities will enhance safety of a harbour. I think that either there is some numerical manipulation mistake or the initial expert assessments (including their relative weights) were biased. This leads me back to the observation about expert weights

(B2) and missing analysis of consistency of the pairwise comparison matrices (B3).

Response:

Authors want to thank the reviewer for this suggestion. In interaction with the expert team, we have obtained improved input data, so new tables with results are presented (table 4, table 5, table 6 and table 7; figure 2 and figure 3).
According to the final score, the business process (p=2) is the most preferred because it has the highest priority. According to the calculated degree of belief, it may be assumed that all identified processes are significant for the seaport so, in the same time, it can be suggested that the management team has defined an adequate reference model of an organization.

Anonymous Reviewer: C-Technical comments

C1

For a symmetry reason, on P4 it seems to me much more natural to define VL=(1,2,2) and not VL=(1,1,2): just plot the 5 fuzzy numbers VL, L, M, H, VH and see why. Actually it would help the reader in having this plot as a Figure of the manuscript.

Response:

Authors have used 5 linguistic expressions which are modelled by using TFNs. The domains of these fuzzy numbers are defined on the set of real line into 1-5. As there are no formal guidelines and rules to determine granulation of TFNs, authors assumed than modal values of employed TFNs should be denoted as 1, 2, 3, 4, 5, respectively.

C2

Matrix on P10, row 10 (please, use symbols for identifying mathematical objects more easily!):

- *I guess the $\times 3$ matrix refers to the K = 3 performances and each fuzzy number in the 4-tuples refers to an expert judgement. If this is correct, it should be clearly stated. Furthermore, for consistency of notation, the diagonal elements should be 4-tuples of crisp numbers, something like (1,1,1),(1,1,1),(1,1,1),(1,1,1) that could be conveniently replaced by a convenient multi-dimensional identity symbol such as the one expressed in LaTeX by mathbb1.*
- *In the following, (P12-15), also $\times 4$ (P11) and $\times 5$ appear. It would be good to always state what this dimensionality refers to. I suppose that they refer to $J_k = 4$ KPIs of each performance, and to the I = 5 "business processes", see Tab. 1 of this review.*

Response:

For the reason of symmetry, the elements on the main diagonal are changed in compliance with the reviewer suggestion. In the same time, the dimension of matrices are denoted.

C3

- *on P4, row21: replace "consensus" by "group consensus" and make reference to Step 5 (P5) of the algorithm.*

- *it is unecessary to define again* $\widetilde{W}^e_{kk'} = (...)$ *and* $\widetilde{W}^e_{jj'} = (...)$*, on P6, row 10, after they were introduced in Sect2.2*
- *Remove range of indexes (i=...j=..k=..) in both Eq.(4) and Eq.(5): they were already introduced in Sect2.2;*
- *Eq.(5) could be better rewritten as:*

$$\widetilde{a}_i = \sum_{k=1}^{K} \widetilde{w}_k \widetilde{a}_i^k = \sum_{k=1}^{K} \sum_{j=1}^{J_k} p_{ij}^k$$

- *There is a logical need to insert a separation (new subsection) on P10, row8.*

Response:

- Authors have changed the text in compliance with the reviewer's suggestion. (They make a decision by group consensus.)
- Authors have changed the text in compliance with the reviewer's suggestion.
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  $\widetilde{a}_i = \sum_{k=1}^{K} \widetilde{w}_k \cdot \widetilde{a}_i^k$, i=1..I, j=1..$J_k$, k=1..K. Eq. (5)
- New subsection has been incorporated as reviewer suggested.
  4.1 Business processes' ranking on real life data