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Idea Management System Application Type Impact on Idea Quantity

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Abstract

Idea management system application considers idea quantity as the key to idea management success. The aim of this paper is to examine how different idea management system application types impact idea quantity. The authors conducted empirical research by conducting a survey based on adaptive structuration theory framework. In the research paper, an analysis of 447 responses was included.
The study shows how to separate idea management system application types impact by idea quantity. The target group consisting of commercially available web-based idea management system applied enterprises bias present in the survey research may limit the generalisability of the results. The study contributes to the discussion about the idea management system application type impact on the idea management results by showing that different idea management system application types lead to different idea management results.

KEYWORDS: Idea management systems, Idea quantity, Survey research, Web-based idea management, Innovation.

Introduction

Innovation management and application of information technologies in organisations has become increasingly more relevant over the last few decades. Web-based idea management systems (IMS) fall in line with the current developments (e.g. growing importance of ICT, the spread of open innovation and co-innovation, etc.) in all previously mentioned considerations, IMS is a manageable systematic tool to generate and evaluate ideas. The use of web-based IMS has become a part of the organizational culture in various enterprises and Web-based IMS are used by many well-known organizations such as Boeing, P&G, Volkswagen, Xerox, Pentax, Heineken, Panasonic, Sony, Fujitsu, Electrolux, Volvo, etc. The authors expect that throughout the following years the role of web-based IMS will grow as even more organizations will start to apply them. Many good examples show positive effects on organizations performance that use web-based IMS. For example, BT Group is using its IMS Webstorm which helped the company acquiring 10 000 new ideas in the seven years between 2005 and 2012. Realization of these ideas has helped the company to increase its revenue by 100 million pounds and improve customer loyalty (Bright Idea, 2010). Another example is Bruce

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Power, the only privately owned nuclear power station in Canada. In two years since it started using IMS Idealink Open, it has acquired more than 2700 new ideas and more than 10 000 participants have participated in their IMS process (generation, development). The use of IMS can lead to both a decrease in costs and an increase in revenue (Brain Bank, 2014). Application cases show that this tool gives the possibility to connect internal and external idea creators and evaluators in the idea management (IM) process and these systems could connect different entrepreneurship areas, for example, intrapreneurship and innovation management, opportunity identification and creation. But there is a lack of research on the web-based IMS application types and their respective results. Authors of this paper aim to explore web-based IMS application type impact on its application results. To fill the gap, authors apply theoretical and empirical approach with the main aim to examine how different IMS application types impact IMS results.

Applegate (1986) is the first researcher mentioning IM and to begin IM and IMS research. Since then there have been several academic perspectives on how to research IM and IMS. A majority of researches focuses on systematic aspects of IM and IMS (e.g. Bailey and Horvitz, 2010; Barczak et al., 2009; Bjork and Magnusson, 2009; Coughlan and Jahanson, 2008; Flynn et al., 2003; Galbrait, 1982; Gish, 2011; Green et al., 1983; Korde and Paulus, 2016; Vandenbosch et al., 2006) and structural (e.g. Bassiti and Ajhoun, 2013; Bergendah and Magnusson, 2014; Divakaran, 2016; Luo and Tobia, 2015; Narvaez and Gardoni, 2015; Poveda et al., 2012; Summa, 2004; Voigt and Brem, 2006; Westerski and Iglesias, 2011; Wooten and Ulrich, 2015). Structural literature sources focus on design and the process, but systematic literature sources focus on social capital, creativity, cognition, etc. (Rose and Jensen, 2012).

Authors have revealed in the previous researches that there are multiple types of research available with a structural perspective that provide a theoretical base for IMS concept exploration. Literature about IMS overviews mostly focus on existing IMS and their application and potential improvements (e.g. Summa, 2004; Bakker et al., 2006; Coughlan et al., 2008; Bothos et al., 2008; Bjork et al., 2009; Barczak et al., 2009; Beretta, 2015; Tung et al., 2009; Bailey et al., 2010; Hrastinski et al., 2010; Holzblatt et al.,2011), but some researches also aim to research development of new IMS (e.g. Flynn et al., 2003; Vandenbosch et al., 2006; Bothos, et al, 2009; Iversen, et al., 2009; Bansemir et al., 2009; Bettoni et al., 2010; Xie et al.,2010; Bothos et al., 2012; Lowe and Heller, 2014). This paper aims to be part of the first type of papers which explores existing systems focusing on commercially available systems. Most researches that explore existing IMS research focus on one or a few IMS but this research is based on a survey across multiple different IMS users.

IMS has not been given sufficient scientific attention and it should be researched how different IMS types impact its application results (van den Ende et al., 2015). This research is aiming at providing a contribution to fill this gap. First, the paper will help researchers and IMS users to understand the basic IMS application types and their potential results. Second, the exploration of different IMS types and their results could motivate entrepreneurs to re-evaluate their current approach to IM. Third, developers and users of web-based IMS see the potential of these systems but positive outcomes often do not occur and that is one of the reasons why organizations do not use them in the long term (DeSanctis and Poole, 1994). Due to these reasons, it is important to explore web-based IMS application types and their results, to explain what results companies could expect based on different application types.

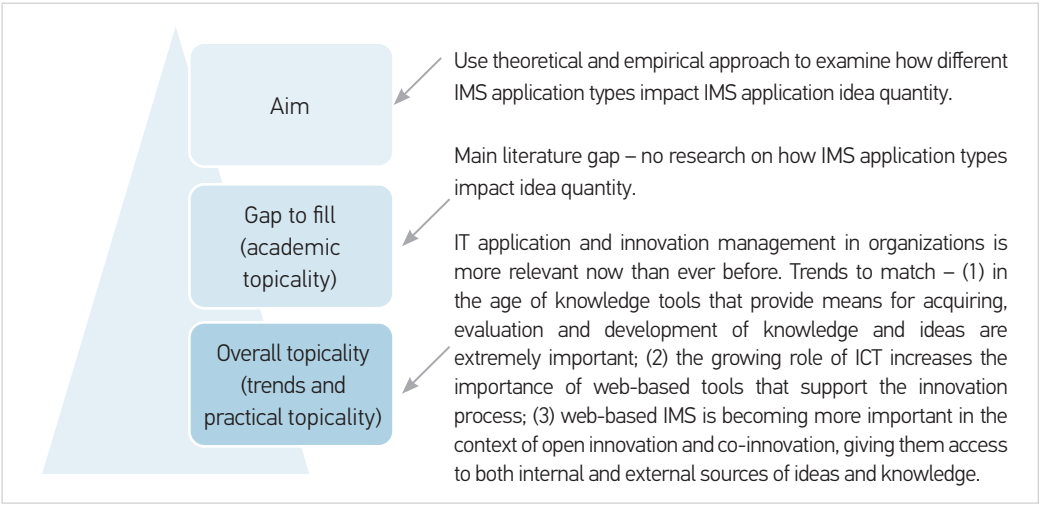
In this paper, IM is defined as a systematic, manageable process of idea generation, evaluation, and repeated idea generation and evaluation. The IMS is defined as a tool, tool kit or complex system which provides systematic, manageable process in IM (Mikelsone and Liela, 2015). The authors use 2 IMS classifications: based on involved idea sources (internal, external, mixed) and based on the application focus (active, passive). The research aims to answer the research question: How different IMS application types impact idea quantity? To answer these questions 4

hypotheses will be tested that are based on the 3 types of IMS and 4 dimensions of the results:

- (H1) Active IMS provide higher idea quantity than passive.
- (H2) External IMS provide higher idea quantity than internal.
- (H3) Mixed IMS provide higher idea quantity than internal.
- (H4) Mixed IMS provide higher idea quantity than external.

Figure 1 summarizes the motivation for this paper.

Figure 1
Research development motivation

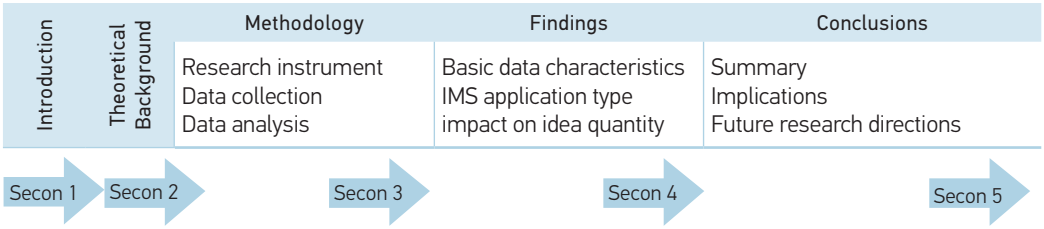


Source: created by author's

This paper fulfils an identified need to clarify IMS types and their impact on idea quantity. This paper creates academical contribution: it researches different classifications of IMS and their impact on idea quantity. Practical contribution - web-based IMS application types and their idea quantity could help to evaluate the potential application of IMS in different scenarios.

The rest of the paper is structured as follows. The second section introduces the theoretical background. The third section continues by presenting the research methodology. The fourth section provides the answers to the research questions through conducted research. This structure can be seen in Figure 2.

Figure 2
Paper Structure



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Theoretical background

Idea management system basic assumptions

In this paper, the definition of the IM is based on the following assumptions that that IM is: (1) systematic process; (2) manageable process; (3) main parts of IM are idea generation, evaluation, and repeated idea generation and evaluation (if it is needed). Based on these assumptions IMS is a tool, tool kit or complex system which provides systematic, manageable process in IM (Mikelsone and Liela, 2015). Table 1 provides a detailed description of IMS, characterising all previously mentioned elements with its sub-elements.

Table 1
IMS Main Characteristics

IMS - tool, tool kit or complex system which provides systematic, manageable process of:		
Idea generation (preparation, capture/gathering of ideas, retention, enhancement)	Idea evaluation (screening, selection, retention)	Continuation of IM (concept development, distribution of ideas, support during implementation with repeated IM and rewarding, retention)
e.g. Korde and Paulus, 2016; Wooten and Ulrich, 2015; Summa, 2004	e.g. Westerski, 2013; Summa, 2004	e.g.Summa, 2004

Source: based on Mikelsone, Volkova and Liela (2019)

There are 3 IM types: external, internal and mixed IM. External IM means external idea generation and evaluation (main IM sources – experts, partners, customers and other stakeholders outside the organization) (e.g. Bothos et al., 2008; Tung et al., 2009; Westerski et al, 2011; Bothos et al., 2012). Internal IM is internal idea generation and evaluation in an organization (main IM source employees) (e.g. Iversen et al., 2009; Fatur et al., 2009; Bansemir et al., 2009; Glassmann, 2009; Klein and Lechner, 2010; Bettoni et al., 2010; Selart and Johansen, 2011; Shani et al., 2011; Moss et al., 2011; Deichmann, 2012; Aagaard, 2012, 2013; Poveda et al., 2012; Bassiti and Ajhoun, 2013, Wood, 2003). Mixed IM - idea generation and evaluation involving internal and external sources (e.g. Fritz, 2002; Nilsson et al., 2002; Voigt et al., 2006; Brem et al., 2007; Enkel et al., 2009; Brem et al., 2009; Sandstrom and Bjork, 2010; Baez and Convertino, 2012).

Idea management system application types

For this research the authors have applied two categories for classifying IMS application: (1) based on the involved IM source; (2) based on the IM application focus.

There are other possible categories for IMS classification: based on the provided process functions (limited, full, extra) and based on the IMS price type (monthly payment, yearly payments). The last two types of classifications will not be investigated further as they focus on systems, not on their application type.

Authors based on the ideas divide all IMS application cases as follows:

- internal IMS by involvement internal idea creators and evaluators;
- external IMS by involvement external idea creators and evaluators;
- mixed IMS by involvement internal and external idea creators and evaluators.

Based on the application focus all systems could be divided as "active" and "passive", therefore, there are passive and active IMS. Passive IMS collect all ideas in an unfocused manner, but active IMS provide functions to collect ideas in a focused manner and most cases includes idea evaluation possibilities. IMS type descriptions are provided in Table 2.

Table 2
IMS Application Types

Classifications					
Classification criteria: ***based on the application focus***					
Passive IMS		Active IMS			
Functions	*Type of focus*	*Functions*		*Type of focus*	
Focus on idea generation	Unfocused process	Focus on all IM dimensions		Focused process	
Classification criteria: ***based on the involved IM source***					
Description	*Main IM source*	*Description*	*Main IM source*	*Description*	*Main IM source*
IMS that allows involving only internal IM sources	Employees	IMS that allows involving only external IM sources	Crowds, experts, clients, etc.	IMS that allows involving internal and external IM sources	Employees; clients, experts, crowds, etc.

Source: based on Mikelsone, Volkova and Liela (2019)

Idea Management System Application Results

Quality and quantity of ideas are most often used as measurements for IM and IMS application, and as a result, should be considered as the main elements of the web-based IMS application outputs. Denis and Garfield (2003) have revealed that decision support system processes may encourage more participation that also provides a challenge to research this element in the IMS context. Wooten and Ulrich (2015) had researched feedback importance in the idea management process, based on the conclusion that managers face a decision about if and how to provide in-process feedback to the idea generators about the quality of submissions. Their research revealed that directed feedback benefits the average quality of entries submitted. The stimulus that impacts web-based IMS application and its results can also be researched. The authors have concluded that there is no common view on IMS output elements, except idea quality and quantity, and involvement. It would be advisable to create IMS effectiveness evaluation tool that would include the most important output elements. In this research, authors will apply the most frequent researched IMS output variables - idea quantity, idea quality and involvement. Idea quality could be defined as the average quality of generated ideas (idea creativity) (Selart & Johansen, 2011; Deichmann, 2012; Bjork & Magnusson, 2009). Idea quantity could be defined as a number of ideas generated (MacCrimmon & Wagner, 1994; Korde & Paulus, 2016; Girotra & Ulrich, 2010; Deichmann, 2012). There is an additional variable chosen to research results – involvement or number of involved people (Dennis & Garfield, 2003; Deichmann, 2012). In this research, authors focus on idea quantity.

Methodology

Research instrument for measuring web-based IMS application results

A questionnaire was created for web-based IMS applied companies. The survey was conducted in the summer/autumn of 2018. Methods for obtaining primary data are described in Table 3.

This survey results allowed to compile data on IMS in 8 blocks, according to Adaptive Structuration Theory: (1) type of IMS; (2) tasks; (3) organization system; (4) adaptation and type of use; (5) IMS results; (6) organisational effectiveness; (7) new structures; (8) problems with the use of IMS. Table 4 highlights the survey block - IMS results.

A total of 186 elements are summarized in 8 question blocks. In this paper, the applied survey block is IMS results. The questionnaire was created and distributed in English, as the dominant language of the IMS and its use in English. All criteria were based on literature analysis and updated scales were based on the results of the case studies as used to describe the results of the application of IMS.

Data collection

The survey was conducted on the survey platform 'The QuestBack' (https://www.unipark.com/) created by UNIPARK. This platform was chosen because it is: (1) focused on academic surveys; (2) widely recommended by world-class researchers; (3) provides data security required by IMS representatives - BSI-certified data centre in accordance with ISO 27001; (4) complies with the requirements of the EU General Data Protection Regulation.

To test the questionnaire, it was sent to 9 companies that conducted a survey and were able to comment on any question. The test was done in 3 rounds, the questionnaire was sent to 3 companies using the IMS when comments were received and based on the feedback the questionnaire was improved. In the third round, comments on the structure or clarity of the questions were no longer provided. Based on the tests, the time of completing the questionnaire was determined (20-30 minutes). After the test, the survey results were deleted.

It should be noted that to reach the target audience more accurately, the authors asked IMS developers to distribute the survey to their clients. It was stipulated that the survey should only be sent to companies using the system in question to the person in charge of the IMS (mostly think-tanks, innovation managers or business managers). In the authors' private communication with 107 IMS

Table 3
Primary data selection un analysis description

Aim	Data selection	Data analysis	Period	Steps
IMS application types impact on the results	Survey of the enterprises that applies web-based IMS (n>400)	Statistical analysis (frequency distribution, standard deviation, t-statistics, degrees of freedom (df), critical values (tc) and p-values, etc.)	3r quarter of 2018	1 Survey development based on literature analysis and developed classifications. 2 Round survey test (data not included in the analysis). 3 Survey distribution to 107 web-based IMS developers, that they could distribute to their clients. 4 400 valid surveys. 5 Standard deviations to evaluate the data consistency for the analysis. 6 Data analysis through selected methods

Source: created by author's

Table 4
Questionnaire Section – IMS Results

Question	Scale	Based on
Idea quantity - What is the average number of ideas created per task?	None	Based on the literature studies and empirical case studies conducted by the authors
Using internal IMS	To 10	
Using external IMS	11 - 100	
Using mixed IMS	101 - 1000	
Using active IMS	1001 - 5000	
Using passive IMS	5001 - 10 000 More than 10 001	

Source: created by author's

developers and the information published by the IMS concerned, it was concluded that the IMS employs around 70, 000 - 100,000 companies (derived from the average number of IMS clients).

Invitation for their system applicants to involve sent to 108 idea management system creators – *Crowdicity, Viim, IdeasMine, Idea Drop, Ideanote, Receptive, CrowdWorx Innovation Engine, Ideawake, Sideways 6, OrganisedFeedback, Exago SMART, Ideation360, ProdPad, Vetter Online Suggestion Box, IdeaLab, GroupMap, Ideaflip, IDEAFOX, iMindQ, Innovation Cloud, innovation5g.com, MindView 7, WE THINQ, eXo Platform, IdeaScale, HYPE Innovation, MindManager, Milanote, Innovation Platform, Kindling, Coggle, DataStation Innovation Cloud, SprintGround, Be-novative, BrainStorm, Idearium, Stormboard, MangoApps, Nova-Innovate Innovation Management Software, Wizeline, Comapping, FeatureMap, Glint Innovation, Ideacomb, Mindomo, SoapBox, Sprint, Wave, Work by InnoCentive, Braincatena, BrightSpars, Bubbl.us, CogniStreamer, De Idee Management Tool, e-Zassi, easycrit, eVSM, Firefly, GainX, germ.io, Headstarter, HiFISH, Hives.co, id-Force, ID8 Enterprise, Ideabox, IdeaBridge, Ideafactory, Ideakeep, IdeaLinker Accelerate, Ideasbank, IDhall SC, Includer, INDONIS, Inno360, InnoEngines, innosabi, Innovation Agora, Innovation Central, InnovationCast, InnovationStation, Innovbook, ITONICS Ideation, MindApp, Nosco, NovaMind, Onyx Cloud Ideas, Orchidea, PIT, Postwaves, SocialJsIdeas, Solverboard, Sophia, TalkFreely, Verve, Vocoli, Yambla, Accept360, Idea Glow, IdeaSpotlight, Idea Management Software by Planbox, Brightidea, IDEALYST, Online Suggestion Box, Flagpole, Spigit Idea Management Software, Academy of Ideas.*

Data analysis

To validate data for the further analysis the pre-analysis was conducted by using the following methods:

- Point estimation and interval estimation – "the process of providing a numerical value for a population parameter based on information collected from a sample. If a single figure is calculated for the unknown parameter, the process is called point estimation. The process of providing a

numerical value for a population parameter based on information collected from a sample. If an interval is calculated which is likely to contain the parameter, then the procedure is called interval estimation" (Everitt & Skrondal, 2010);

- Frequency distribution – "the division of a sample of observations into a number of classes, together with the number of observations in each class. Acts as a useful summary of the main features of the data such as location, shape, and spread" (Everitt & Skrondal, 2010);
- Mean of the group - to get the average value of the group;
- Standard deviation – to measure the spread of a set of observations;
- Modal and medial class (interval) – to observe the most frequent and "the value in a set of ranked observations that divides the data into two parts of equal size" (Everitt & Skrondal, 2010);
- Coefficient of variation - to measure "the spread for a set of data defined" (Everitt & Skrondal, 2010);
- Confidence interval – to range the values, calculated from the sample observations, that is believed, with a particular probability, to contain the true parameter value (of the population);
- Sampling error – to observe "the difference between the sample result and the population characteristic being estimated" (Everitt & Skrondal, 2010).
- To test the hypothesis the following data analysis methods were applied:
- Significance tests for a population mean number for the result variable.
- The *t*-test was used to measure statistically significant variations between IMS types. It was applied to test the hypothesis.
- Calculating *p*-values for the given test statistics and the degrees of freedom.

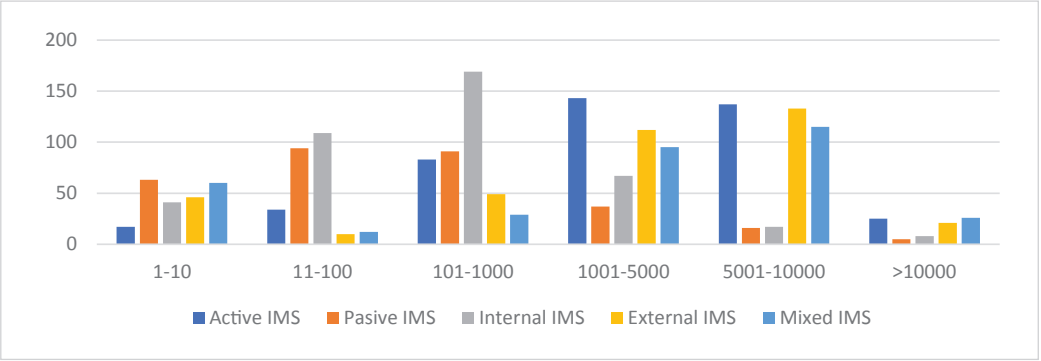
Findings

Basic data characteristics – idea quantity

Respondents frequency distribution based on survey data is shown in Figure 3.

Figure 3

Respondents frequency distribution for idea quantity based on sample data



Source: created by author's

The further detailed analysis consists of the arithmetic mean of the group, standard deviation, modal and medial class (group), coefficient of variation.

Arithmetic mean of grouped data is calculated as follows:

$$\bar{x} = \frac{\sum_1^K f_i * m_i}{n} \quad (1)$$

where: m_i - *i*th class (group) midpoint, f_i - frequency of the *i*th class (interval), n - sample size, $n = \sum_1^K f_i$.

The standard deviation of grouped data is calculated as follows:

$$s = \sqrt{\frac{s^2}{n} * \left(1 - \frac{n}{N}\right)} \quad (2)$$

where: $s^2 = \frac{1}{n-1}\sum_1^K f_i * (m_i - \bar{x})^2$, m_i - *i*th class (group) midpoint.

The median (*Me*) of grouped data is calculated as follows:

$$Me = x_{Me,l} + \frac{\left(\frac{\sum f}{2} - cf_{Me-1}\right) * \Delta_{Me}}{f_{Me}} \quad (3)$$

where: $x_{Me,l}$ - *lower class boundary of the interval containing the median,* $cf_{Me\text{-}1}$ – cumulative frequency of the interval before the median interval, f_{Me} - *frequency of the median interval,* Δ_{Me} - *the median interval width.*

Medial interval is interval for which accumulated frequencies first time is equal or larger than half of the sample size.

Coefficient of variation (*CV*) is calculated as follows:

$$CV = \frac{s}{\bar{x}} * 100\% \quad (4)$$

Point estimates were aggregated and are provided in Table 5.

Table 5
Point estimates for idea quantity

IMS type	n	Mean	Median	S	CV
Active IMS	439	4138,6	3392,1	3500,6	85%
Pasive IMS	306	1141,1	96,7	2313,7	203%
Internal IMS	411	1284,3	396,1	2299,2	179%
External IMS	371	4377,1	3875,5	3543,5	81%
Mixed IMS	337	4420,1	3842,6	3771,4	85%

Source: *Authors' constructions*

As shown in Table 5, the medians for all IMS types are less than the means of the generated ideas. These differences indicate some asymmetry in the distribution of respondents - more often a smaller number of ideas are generated, but less often - a large number of ideas. There is a particularly large difference between these indicators for passive IMS as well as for internal IMS - as frequency distributions are skewed mean values does not give a good idea of a typical value that can be expected in case of using these types of IMS. The calculated coefficients of variation also indicate similar - passive and internal IMS has more variation, relative to its arithmetic means than other IMS application types.

Further described is the interval estimation for the population mean. The confidence interval for the population means μ is calculated as follows:

$$\bar{x} \pm ME \quad (5)$$

where: ME - margin error,

$$ME = t_{n-1,\alpha/2} * \frac{s}{\sqrt{n}} \quad (6)$$

where: $t_{n-1,\alpha/2}$ - value of t distribution for the selected confidence level and sample size, α - level of significance and 100*(1– α)% - confidence interval.

The upper confidence limit (UCL) is calculated as follows:

$$\text{UCL} = \bar{x} + ME \quad (7)$$

The lower confidence limit (LCL) is calculated as follows:

$$\text{LCL} = \bar{x} - ME \quad (8)$$

Confidence intervals (CI) provide the lower confidence limit (LCL) and the upper confidence limit (UCL) that are likely to contain the true parameter value (of the population). The value 95% refers to the probability that the interval will capture the parameter being estimated (Tan & Tan, 2010). 95% confidence interval estimates are aggregated in Table 6.

Table 6

Mean values, margin errors and 95% confidence interval estimates for idea quantity

IMS type	Mean	*Me*	LCL	UCL
Active IMS	4138,6	167,1	3810,2	4466,9
Pasive IMS	1141,1	132,3	880,9	1401,4
Internal IMS	1284,3	113,4	1061,4	1507,3
External IMS	4377,1	184,0	4015,4	4738,9
Mixed IMS	4420,1	205,4	4016,0	4824,2

Source: created by author's

A 95% CI means that if the study will be conducted multiple times with corresponding 95% CI for the mean constructed, author's expect 95% of these CI's to contain the true population mean (Tan & Tan, 2010) and it could be between 3810 to 4467 ideas generated in active IMS, for passive IMS between 881 to 1401, for internal IMS between 1061 to 1507, external IMS between 4015 to 4739 and mixed IMS between 4016 to 4824.

Hypothesis testing – idea quantity

Basic data set analysis showed that it is possible to test the hypothesis on the gathered data. That is the reason why further in this paper the authors conduct significance tests for population mean number of ideas created (idea quantity). A respondent's frequency distribution shows the main trends that will be tested: (1) active IMS provides higher idea quantity than passive IMS; (2) external IMS provides higher idea quantity than internal IMS; (3) mixed IMS provides higher idea quantity than internal and external IMS. See in Figure 8.

Hypothesis tested:

(H1) Active IMS provide higher idea quantity than passive:

H_0: $\bar{x}_{AC} - \bar{x}_{PC} \leq 0$ and H_A: $\bar{x}_{AC} - \bar{x}_{PC} > 0$

(H2) External IMS provide higher idea quantity than internal:

H_0: $\bar{x}_{EC} - \bar{x}_{IC} \leq 0$ and H_A: $\bar{x}_{EC} - \bar{x}_{IC} > 0$

(H3) Mixed IMS provide higher idea quantity than internal

H_0: $\bar{x}_{MC} - \bar{x}_{IC} \leq 0$ and H_A: $\bar{x}_{MC} - \bar{x}_{IC} > 0$

(H4) Mixed IMS provide higher idea quantity than external

H_0: $\bar{x}_{MC} - \bar{x}_{EC} \leq 0$ and H_A: $\bar{x}_{MC} - \bar{x}_{EC} > 0$

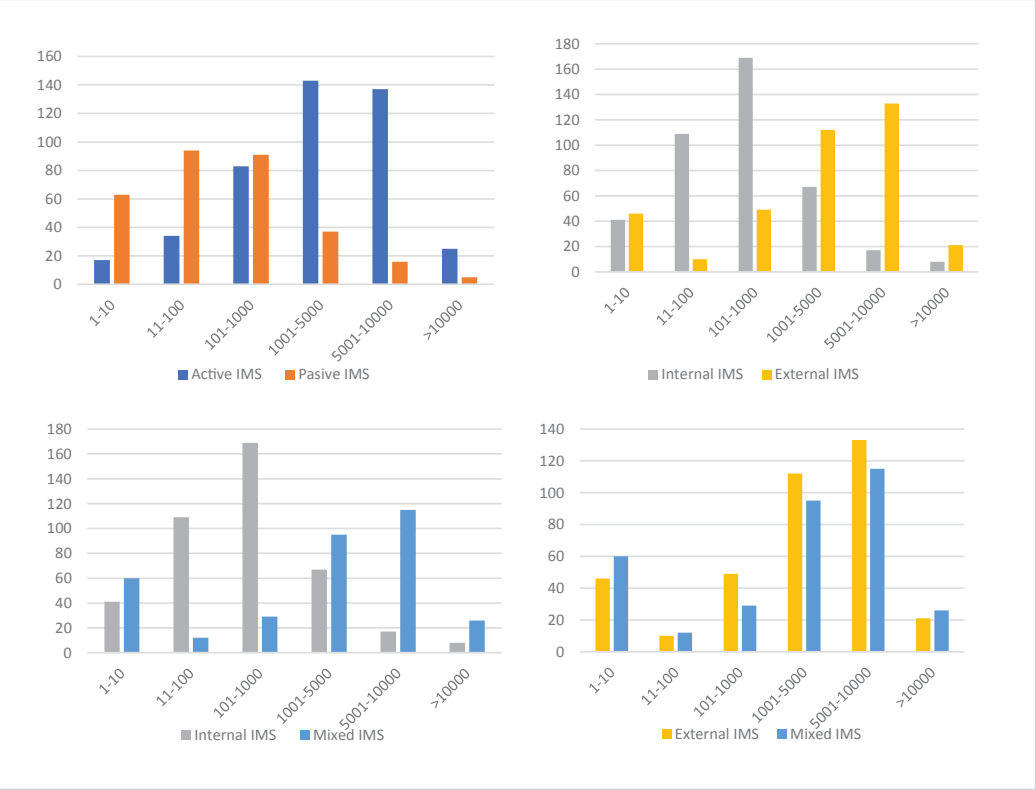


Figure 8

Respondents frequency distribution for idea quantity based on sample data

Source: created by author's

As sample sizes un standard deviations differs, the test statistics are calculated as follows, (Moore et al. 2016):

$$t = \frac{\bar{x}_i - \bar{x}_j}{\sqrt{\frac{s_i^2}{n_i} + \frac{s_j^2}{n_j}}} \tag{9}$$

where $\bar{x}_i$ and $\bar{x}_j$ means of comparable sample variables, s_i^2 and s_j^2 variance (standard deviation squared) of comparable samples variables, n_i and n_j sample sizes of comparable samples and compared with *t*-statistics critical values $t_{v,\alpha}$,
where degrees of freedom (*df*) for the *t*-test statistics are calculated as follows:

$$df = \frac{\left[\left(\frac{s_i^2}{n_i}\right) + \left(\frac{s_j^2}{n_j}\right)\right]^2}{\frac{\left(\frac{s_i^2}{n_i}\right)^2}{(n_i - 1)} + \frac{\left(\frac{s_j^2}{n_j}\right)^2}{(n_j - 1)}} \tag{10}$$

lso, *p*-values were calculated for given test statistics and the degrees of freedom. The *p*-value is the probability of obtaining a value of the test statistic as extreme as or more extreme than the actual value obtained when the null hypothesis is true. Thus, the *p*-value is the smallest significance level at which a null hypothesis can be rejected, given the observed sample statistic. Calculated *t*-statistics, degrees of freedom (*df*), critical values (t_c) and *p*-values are aggregated in following Table 7.

Table 7
Hypothesis test statistics for idea quantity

Pairs tested	*t*	*df*	*tc*	*p*- value
AIMS vs PIMS	14,07	741,05	1,96	<0,0001
IIMS vs EIMS	14,31	623,41	1,96	<0,0001
IIMS vs MIMS	13,36	531,54	1,96	<0,0001
EIMS vs MIMS	0,16	688,74	1,96	>0,05

Source: *created by author's*

From test results, authors would reject the null hypothesis 1, 2, 3 and conclude that sample data provide strong evidence to support conclusions that:

- (H1) Active IMS provide higher idea quantity than passive;
- (H2) External IMS provide higher idea quantity than internal;
- (H3) Mixed IMS provide higher idea quantity than internal.

These conclusions are supported by very low ***p***-values (<0,0001).

Regarding H4 authors cannot reject the null hypothesis because $t < t_c$ and ***p***-value >0,05 – so sample data does not give sufficient evidence that mixed IMS provide higher idea quantity than external.

Conclusions

There is strong statistical evidence to support conclusions that:

- Active IMS provide higher idea quantity than passive.
- External IMS provide higher idea quantity than internal.
- Mixed IMS provide higher idea quantity than internal.
- Paper does not have sufficient evidence that mixed IMS provide higher idea quantity than external.

This research fulfils an identified need to clarify IMS types and their impact on the results – idea quantity. This research delivers the following academical contribution: '

1. it is the widest web-based IMS empirical research based on the survey;
2. approbated classifications of IMS;
3. it researches different classifications of IMS and their impact on idea quantity.

- The practical contribution of the research results helps to understand what kind of results enterprises could expect from different IMS application types.
- Research results highlight the benefits/implications of adopting different types of IMS for organizations. These contributions also provide managers with a richer set of theoretical tools, enabling them to make better decisions regarding the selection of IMS that are the best for achieving the results in the given context. Web-based IMS types and their impact on the IMS results could help to evaluate the potential application of these systems in different application scenarios.
- This research concentrated only on commercially available web-based IMS, but further research could include insights from non-commercially/private IMS, as well as real-life IMS. Additional research should be done to compare real-life and web-based IMS. Also, detailed research is needed to explore why standard deviations and coefficient of variations are so high.
- Further research should provide evidence on what benefits the different classes of IMS provide to organizations and also on other IMS results, such as, idea quality and involvement. This also coincides with van den Ende et. al. (2015) call to research different IMS types and their results. The research delivered by authors is the first attempt to answer this question, but there are a lot of additional questions to be answered. The authors are convinced that this paper will attract the interest of more researchers regarding IMS types and their impact on its results.

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